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AUTHOR Leeper, Herbert A., Jr.; Iverson, Rachel L.
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ABSTRACT

The report examines vocal frequency differences between normal speaking children and 65 children (mean age 9-years) with vocal nodules and accompanying vocal quality disturbances. In part I of the study children were screened by a physician and their voices were recorded and analyzed by a digitizer-computer system for mean vocal frequency, frequency variability, basal frequency, frequency range, and amount of frequency skewness for sustained vowel phonations. Among findings was that of the vocal frequency measures studied, only basal frequency differentiated the two groups. The second part of the experiment related 15 perceptual factors and one physical variable to the ratings of overall vocal efficiency. The results suggest that listeners can accurately scale voices along a severity continuum and relate this to judged voice characteristics. (Author/PHR)

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FINAL REPORT

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Institution
Oklahoma State University of
Agriculture and Applied Science

Principal Investigator
Herbert A. Leeper, Ph.D.

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FINAL REPORT

Project Title: Vocal Frequency Measures in Normal Speaking Children and Children With Vocal Deviations

Project Investigators: Herbert A. Leeper, Jr. and Rachel L. Iverson

Project Number: O.E. - G007604398

NARRATIVE

This report will be divided into eight categories, namely: project goals, equipment and supply purchases, personnel activities, physician's screening results, vocal frequency data collection, results, conclusions, and clinical implications.

1.1 Project Goals

This grant was designed to evaluate the vocal frequency characteristics of normal speaking children and children with vocal nodules and accompanying voice deviations. To obtain this information, a comparison of the model vocal frequency productions for each group was described for a structured (therapy room) and non-structured (classroom) situation. Tape recordings were made of each child's vocalization utilizing a high quality tape recorder and/or a wireless FM transmitter-receiver system in these situations. Measures of mean vocal frequency, frequency variability, basal frequency, frequency range, and amount of frequency skewness for sustained vowel phonations and connected speech samples over a two day period was used for the analysis. These measures were correlated with perceptual judgments of vocal efficiency. The resultant information will be used to aid the school speech pathologist in providing new methods of diagnosis for the voice defective school age child.

1.2 Equipment and Supply Purchases

Since the third quarter, the following supplies, materials, and services have been purchased and utilized by the investigators:

1. Audio and video magnetic tapes
2. Office supplies
3. Computer services (off-campus)-Purdue University
4. Computer Services and keypunching (on-campus)-Oklahoma State University
5. Consulting Services:
    a. Dr. Yoshiyuki Horii
    b. Dr. Joseph Leonard
    c. Dr. Kenneth W. Burk
    d. Dr. John F. Michel
6. Travel funds

The total encumbered funds for these supplies and services was $8,774. This amount included with earlier expenses added to $9,261.00 spent on the project.

1.3 Personnel Activities

Since the third quarter, the investigators have spent most of their time dubbing and analyzing the audio tapes made for each child.

To make the tapes ready for the unique digitizer-computer system at Purdue University, the investigators prepared the tapes such that each tape was aligned for each condition (Normal-Deviate), each day (Tuesday or Thursday), and for each time of day (Morning, Noon, Afternoon). Each master tape was placed on a separate 7½ inch reel and marked with appropriate identification. The order of subject placement on each tape was consistent with the recording of that child in the school situation. The order of playback to the digitizer-computer was consistent with the recording procedure for each child, that is, vowel samples, contextual speech, and free field.

The digitization-computer analysis portion of the experiment at Purdue University took approximately five days. Digitization of the material was provided with the help of Dr. Yoshiyuki Horii from the Department of Audiology and Speech Science using the special access computer in the Department of Electrical Engineering. Following the digitization, the disc-stored-data were presented to Purdue University's main computer center for analysis and reproduction. For computer re-analysis and statistical manipulation, the investigator then recoded 930 data points.

Inclusion of mean, median, modal, frequency variability, range of frequency and skewness data equaled some 7,200 separate pieces of data to be statistically manipulated at the Oklahoma State University Computer Center.

Following the computer re-analysis, the investigators compiled the results for presentation in the final form of the report. During the analysis period both Dr. Kenneth Burk and Dr. John Michel visited the investigators on campus to discuss the statistical analysis and interpretation of the results.

1.4 Otorhinolaryngologic Screening of Children with Suspected Vocal Quality Differences

Voice problems are common enough in school age children to constitute important diagnostic and treatment considerations for speech pathologist in the position of providing services for all handicapped school children. Recent estimates of the incidence of voice disorders in school age children have come from investigations by Pont (1965), Baynes (1966), Senturia and Wilson (1968), and Silverman and Zimmer (1975). These authors have indicated that approximately six to nine percent of the school age children they studied had "hoarse" voices and underlying vocal fold lesions.

Further, the incidence of vocal fold lesions and accompanying vocal deviation was found to be higher in the primary grades, kindergarten through third grade. In addition, more male children were found to have vocal disturbances than female children at each grade level. The higher incidence of vocal disturbances in children over the past ten years may be indicative of the increase in the emphasis placed on the verbal communication skills of the younger children. It is also suggested that better clinical preparation of school speech pathologist may have improved the identification procedures used to determine vocal differences in school age children.

As a portion of this research grant, the investigators were concerned about the number of children in grades one through five of the Stillwater Public Schools that have vocal quality disturbances and accompanying vocal fold lesions. In this portion of the final research report, the investigators will limit observation to the ear, nose, and throat of each of the 65 vocally deviant children upon whom complete data was collected. From this group, preliminary indications concerning the origination of the laryngeal changes may be determined.

Initially, two speech pathologists (H.A.L.;R.L.I.) screened 1,481 children in grades one through five in the Stillwater Public Schools. From this group, 104 children or 7% of that total were found to have laryngeal qualities which differed "perceptually" from normal. Upon rescreening two months later, 78 children or 5% had vocal qualities still different from normal. These 78 children were scheduled for medical review by an ENT physician in the school they attended. On two separate days on each of two weeks, one board certified ENT physician (J.E.L.) performed a medical examination upon these children. For the final analysis of the medical data, 65 children or 4% of the total screened are reported. Difficulty in attendance, parental permission, or outside activities (sports, band) or partial information eliminated 13 children.

A review of Table I by the reader will show that the largest percentage of children having a vocal difference on the day of the screening was in grade 3 (24%). The restricted percentage range (15%-grade 2, 24%-grade 3) suggested a rather consistent level of occurrence of vocal deviations across the age range 6 to 11 years.

The predominance of male children (53) (82%) over female children (12) (18%) having vocal quality deviations on the day of the examination may be seen in Table II. This result is in concert with other investigators (Senturia and Wilson, 1968) who found that 66% of the subjects referred were male.

In Table III, the reader may observe that of the 65 children referred for an ENT evaluation, only 8 or 12% could not be visualized or examined by the physician. This is in contrast to the 37% that could not be visualized by one physician in the Senturia and Wilson (1968) study. In addition to using small laryngeal mirrors, establishing a concerned, friendly, rapport with each child appears to be the major difference in obtaining or not obtaining a visualization of the larynx of young children.

It should also be noted that the present examination results were done in the nurse's room or office of each school and not in a hospital examining room or physician's office as reported by Senturia and Wilson (1968). Of the 57 children visualized during the project, 13 children (22%) had normal fold, 25 (37%) had bilateral vocal nodules, and 19 (28%) had bilateral (diffuse) vocal fold thickening.

An examination of the upper respiratory tract to note increased tonsil size, injection of the anterior faucial pillars, or enlargement of the jugulo-digastric lymph nodes by the physician are reported in Tables IV, V, and VI.

TABLE I

DISTRIBUTION BY GRADE OF THE CHILDREN NOTED AS HAVING A VOCAL DIFFERENCE ON THE DAY OF EVALUATION

GRADE	NUMBER
1	14 (23%)
2	8 (15%)
3	15 (24%)
4	14 (19%)
5	14 (19%)
TOTAL	65

TABLE II

SEX DISTRIBUTION OF CHILDREN WITH VOCAL DEVIANCY

ON THE DAY OF THE EVALUATION

	NUMBER
Male	53 (82%)
Female	12 (18%)
TOTAL	65

TABLE III

REVIEW OF CHILDREN NOTED AS VOICE DEVIANT

	NUMBER
Vocal Deviation Not Confirmed (unsuccessful view of cords)	8 (13%)
Normal Cords Confirmed	13 (22%)
Vocal Nodules Confirmed*	25 (37%)
Vocal Cord Thickening Confirmed*	19 (28%)
TOTAL	65

* All instances of vocal cord pathology were bilateral.

TABLE IV

PRESENCE AND SIZE OF TONSILS IN CHILDREN WITH VOICE DEVIATIONS

TONSILS	NUMBER
Removed	8 (12%)
Small	35 (53%)
Medium	12 (18%)
Large	10 (15%)
Very Large	1 (1%)
No Information	1 (1%)
TOTAL	65

TABLE V

PRESENCE OF INJECTION OF ANTERIOR PILLARS

IN CHILDREN WITH VOCAL DEVIATIONS

	NUMBER
None	24 (37%)
Minimal	30 (46%)
Mild	5 (8%)
Moderate	0 (0%)
Marked	0 (0%)
No Information	6 (9%)
TOTAL	65

TABLE VI

PRESENCE AND SIZE OF JUGULO-DIGASTRIC LYMPH NODES IN CHILDREN WITH VOCAL DEVIATIONS

	NUMBER
None	8 (12%)
Small	47 (72%)
Medium	4 (6%)
Large	1 (2%)
Very Large	0 (0%)
No Information	5 (8%)
TOTAL	65

It is interesting to observe that only 8 (12%) of the 65 children had their tonsils removed, while 35 (53%) had small tonsils, 12 (18%) medium sized tonsils, 10 (15%) large, and 1 (2%) had very large tonsils. These percentages differ from the Senturia and Wilson (1968) study in which a larger percentage of children 41 (28%) had their tonsils removed and where 32% had medium sized tonsils.

Minimal injection of the anterior faucial pillars accounted for 46% of the cases in the present study, and no injection in 37% of the cases (Table V). This is in large contrast to the values by Senturia and Wilson (1968) study where 71% of their population had no injection of the pillars.

In Table VI, it may be seen that small jugulo-digastric nodes were found in 47 (72%) of the cases, while 8 children (12%) had no enlargement of these nodes. These values are more in concert with those reported by other investigators.

Table VII is designed to portray the data on secretion in the nasal fossae of children with vocal deviations. By far, most children examined in the present study 43 (66%) had no pus or mucopus in the nasal fossae. Only 30% of the children seen had mucus, pus, or mucopus available to irritate the upper respiratory system. In addition, only 16% (10 children) had any redness or granulation of posterior pharyngeal wall (Table 8) that might support infection of the whole URI tract and coincide with the vocal deviation.

Visualization of the larynx and arytenoids in 88% of the cases (Tables IX and X) showed that 48 cases (74%) had normal coloration, 4 cases (6%) had minimal redness, and 3 patients (5%) had mild redness of the arytenoids. In all cases of redness, the change was bilateral.

Table XI displays the 57 patients in whom the vocal folds were visualized. In the present study, a fairly consistent percentage of children in grades one

TABLE VII

SECRETION IN NASAL FOSSAE AMONG CHILDREN WITH VOCAL DEVIATIONS

	NUMBER
None	43 (66%)
Mucus	14 (22%)
Pus	4 (6%)
Mucopus	1 (1%)
No Information	3 (5%)
TOTAL	65

TABLE VIII

APPEARANCE OF POSTERIOR PHARYNGEAL WALL IN CHILDREN WITH VOCAL DEVIATIONS

	NUMBER
Normal	43 (66%)
Redness	5 (8%)
Granular	5 (8%)
Redness and Edema	0 (0%)
No Information	12 (18%)
TOTAL	65

TABLE IX

APPEARANCE OF ARYTENOIDS IN CHILDREN WITH VOCAL DEVIATIONS

	NUMBER
Normal	48 (74%)
Minimal Redness	4 (6%)
Mild Redness	3 (5%)
Moderate Redness	0 (0%)
Marked Redness	0 (0%)
Edema	0 (0%)
Edema and Redness	0 (0%)
No Information	10 (15%)
TOTAL	65

TABLE X

VISUALIZATION OF LARYNX BY ENT EXAMINER

(of 65 subjects with voice deviancy)

Successful	57	(88%)
Unsuccessful	8	(12%)
TOTAL	65	

TABLE XI

DISTRIBUTION BY GRADE OF VOCAL DEVIANT CHILDREN

WHOSE TRUE CORDS WERE VISUALIZED

(57 Patients)

GRADE	NO CORD LESION	CORD LESION
1	0 (0%)	9 (20%)
2	1 (8%)	5 (11%)
3	6 (46%)	9 (20%)
4	2 (15%)	14 (32%)
5	4 (31%)	7 (16%)
TOTAL	13	44

through five had vocal fold lesions. Only the second grade group had a lower percentage of no fold lesion (8%) and fold lesion (11%) than the other grades. The third and fourth grades had the largest percentages of vocal fold lesions among the groups. It is interesting to note that 13 children (23%) of the 57 children visualized had no vocal fold pathologies yet still retained an abnormal vocal quality. If approximately one quarter (21%) of those children seen in public schools were found to have negative medical examinations (no vocal fold lesions), yet were chronically vocally "rough, breathy, or hoarse" then what must be the underlying physiological reason for the vocal disturbance? Certainly, the medical-legal implications of relying totally on an indirect view of the larynx to support on deny speech pathology management of these cases is subject to criticism under law (PL 94-142). Further research is indicated on this point.

In Table XII it may be seen that by far most of the children with no vocal fold lesions (54%) and those with lesions (70%) had no secretion from the nasal fossae. Further, more children with no vocal fold lesions had mucus, pus, and mucopus (46%) than did the lesion group (28%). These results are supported by the Senturia and Wilson (1968) investigation.

Finally, Table XIII displays the appearance of the arytenoids in vocally deviant children whose larynges were visualized. In sharp contract to the no vocal fold lesion group where none of the children showed arytenoid involvement, 6 children (13%) of the lesion group had minimal or mild redness of the arytenoids. Large percentages of both groups, however, showed no involvement of the arytenoids. This is in contrast to the large numbers of children reported by Senturia and Wilson (1968) who showed edema and redness of the arytenoids.

Because the information gathered in the schools was by necessity of a screening nature, determination of the precise categorization of benign vocal

TABLE XII

SECRETION IN NASAL FOSSAE AMONG VOCALLY DEVIANT CHILDREN WHOSE LARYNGES WERE VISUALIZED

	NO CORD LESION	CORD LESION
None	7 (54%)	31 (70%)
Mucus	4 (30%)	10 (23%)
Pus	1 (8%)	2 (5%)
Mucopus	1 (8%)	0 (0%)
No Information	0 (0%)	1 (2%)
TOTAL	13	44

TABLE XIII

APPEARANCE OF ARYTENOIDS IN VOCALLY DEVIANT CHILDREN WHOSE LARYNGES WERE VISUALIZED

ARYTENOIDS	NO CORD LESION	CORD LESION
Normal	12 (92%)	35 (80%)
Minimal Redness	0 (0%)	4 (9%)
Mild Redness	0 (0%)	2 (4%)
Moderate Redness	0 (0%)	0 (0%)
Marked Redness	0 (0%)	0 (0%)
Edema	0 (0%)	0 (0%)
Edema and Redness	0 (0%)	0 (0%)
No Information	1 (8%)	3 (7%)
TOTAL	13	44

fold lesions (edema, hyperplasia, circumscribed thickening) could not be completed. Further study of these conditions may be warranted.

In conclusion, the children used to develop a base for the physical frequency measures in the present study might be described on the average as follows: 1) male children, 2) 1st, 3rd, 4th, or 5th graders, 3) with small tonsils, 4) with minimal injection of the anterior faucial pillars, 5) small jugulo-digastric nodes, 6) minimal mucus in the nasal fossae, 7) minimal redness of the posterior pharyngeal wall, 8) with minimal redness of the arytenoids, and 9) bilateral vocal fold nodules or thickening at the junction of the anterior 1/3 and posterior 2/3rds of the true vocal folds.

1.5 Vocal Frequency Data Collection and Analysis

Subjects

Initially, the voice defective subjects chosen for the present study were 20 first, second, third, fourth, and fifth grade public school children (15 males, 4 females). These children were selected from the first five grades of the public schools screened by the two speech pathologists and the ENT physician. Due to absences from school, outside activities, or the occurrence of an acute upper respiratory infection (cold), only 15 voice defective children (13 males, 2 females) were used for the final data analysis. The mean age for this group was 9 years, 0 months with a range from 6.5 years to 11.4 years.

Each of these children was medically diagnosed as having bilateral vocal nodules and accompanying deviant voice quality. All had normal hearing, speech and language, and none showed signs of oral-facial or sensory motor involvement as ascertained through the physician's report and reports of the school speech pathologist and classroom teachers. Each child was in the appropriate grade level for his age.

The children in the control group were matched for age, sex, size, and grade level with the 15 voice deviant children. They were chosen from one of the two classrooms for each grade at one of two schools (HP,SL) in the Stillwater School System. These children had normal hearing, speech and language, and showed no signs of oral-facial or sensory motor involvement.

Procedure

Each child's vocal output was tape recorded (Nagra, model 4.2 L) with a high quality microphone (Neuman, model KM 84) during the morning, at noontime, and during the afternoon on each of two days within one week. The testing times began and ended according to the regular daily time schedule of each school.

During the structured recording sessions, each child was escorted from his classroom to a quiet room (nurse's room library office) in his school building. Each was seated in a child size chair 7.6 centimeters from the microphone and told about the phonatory tasks he was to perform. He was instructed by the experimenter to produce the vowel /a/ at his habitual vocal frequency (modal frequency) for five seconds on each of three trials. He was also asked to produce the vowel /a/ at the lowest possible comfortable frequency (basal frequency) on three successive trials. Each child was also asked to produce the vowel /a/ at his highest comfortable sustainable frequency for three trials. The children also were asked to recite the "Pledge of Allegiance" three times during each testing session. Finally, each child was asked to discuss, describe, or "tell a story" about several action pictures. The experimenter recorded the child's output until at least 15 seconds of speech had been recorded.

During the same 7 day period as the structured recording were made, the experimenters recorded each child in the free-field wireless session. In this condition, each child with vocal nodules and accompanying vocal quality deviancy and his matched control were presented with a small, portable wireless mini-microphone transmitter (Vega, model AV-71). The transmitter was placed in a small vest for wear. The children were allowed to move freely throughout the halls of the school, library, and playground during the testing period. A stationary receiving apparatus (Vega, model VA 72, FR Receiver) operating on a standard FM tuning band was situated in the same room used to record the structured voice samples. The tuner was attached to the same high quality tape recorder used to record the structured setting voice samples. The child was not aware when or how much of the various speech samples were being recorded. From the recorded sample, a one minute live segment was selected to be used for the final frequency analysis.

Instrumental Analysis

Each child's voice samples were collected and tabulated for later data reduction. The initial data reduction consisted of dubbing, splicing, and restructuring the audio tapes so that there was one 7½ inch tape reel for each condition, i.e., modal frequency (condition), morning (time), Tuesday (day), normal group (group). The child's position on each tape was logged so that the final computer output could be related to a specific child's vocal output.

All of the samples were digitally processed through a special access computer for storage on computer disc and the data analyzed into analog form using a specially designed computer program for fundamental frequency analysis (Horii, 1975). This program analyzed the fundament frequency of the various experimental recordings by a period-by-period (f_o) tracking procedure developed by Horii (Horii and Hughes, 1972).

In essence, the speech signal is quantized through an analog-to-digital converter at a rate of 10,000 times per second and stored on computer magnetic tape. The frequency is calculated by using second-order maxima of the amplitude of the waveform as primary targets for the peak in any one period of time. Amplitude and period information of preceding segments are also used to decide which target should be tentatively accepted as the "pitch" peak. After all preliminary decisions are made, good strings and bad strings of period values are labelled. At that time, good periods are described as being within 6% of immediately preceding period values. The computer program then expands good strings backward and forward by looking for better targets of the peaks in the waveform data. For output data, the computer program provided a melody plot, distribution histograms and descriptive statistical data such as the mean, median, mode, standard deviation, mid 90% range, mid 50% range, and skewness of each of the subsets of the vocal frequency data.

High repeatability of the procedure has previously been demonstrated (Horii, 1972). Horii has shown that an error size of less than one Hz was obtained for repeated processings of connected speech by adult male speakers.

1.6 Statistical Analysis

Inferential statistics (Analysis of Variance-ANOV) (Winer, 1962) were used to determine differences in vocal frequency measures (Basal, Modal, Connected Speech, Free Field) for the two groups (Normal-Deviate) of children. A multi-factor repeated measures design was employed for the determination of differences in the vocal frequency measures for days, time of day, and voice characteristics. Separate ANOV's were also computed for comparisons of the vocal frequency measures.

The assumption of homogeneity of the population variance-covariance matrix was assumed not to have been significantly violated since the use of conservative degrees of freedom, as suggested by Winer (1962, p. 123), did not change the significance of the obtained results. The other underlying assumptions of the technique of analysis of variance, now believed to be relatively unimportant, as indicated by Box (1953), were assumed to be met.

Since a preliminary test indicated no significant differences between male and female f_o for any conditions, the f_o of the two sexes were pooled for further analyses. Further, because of computer-digitizer problems, Noontime data was eliminated when incomplete results were obtained for portions of each of the two days.

Main Effects on Full Range Conditions

As can be seen in Table 1, the significant F ratio shows a difference between the five measured voice stimuli (Basal, Modal, Pledge of Allegiance, Picture, Free Field) of the experiment. This difference is significant at the .0001 level of confidence.

Whenever the ANOV revealed a significant main effect beyond .05, a Duncan's Multiple Range test for ordered total differences was performed to reveal the source of the significance (Winer, 1962, p. 86). The Duncan's Multiple Range Test of ordered totals for differences in the mean fundamental frequency between the five test-mean vocal stimuli is shown in Table 2. This table reveals, not unexpectedly, that the Basal Frequency condition differs significantly from the other four (Picture, Free Field, Pledge of Allegiance, Modal) frequency means. It is interesting to note that the sustained vowel /a/ Modal condition is approximately 27.5 Hz higher than the average Basal frequency value, while the more conversational Picture condition is only 20 Hz from the Basal value, with other frequency stimuli values falling in between.

No other Main Effects or Interaction Effects between the four sources of measurement were found. A non-statistical trend between the Interaction Effect of Stimuli by classification warranted further consideration.

In Table 3, the reader can see the three-factor ANOV procedure for the Basal frequency data of the normal and deviate voice quality children. Here a significant difference ($F = 5.20$, df, 1, 112) is found between the two groups of children (Normal-Deviate). Review of the descriptive data available in Table 4 for the overall mean Basal frequency differences shows that children with vocal nodules and accompanying voice quality differences have a value 10 Hz higher (211 Hz) i.e., closer to their overall Modal values, than does the normal group (201 Hz). This is true for the Median score (207.5 Hz) as well as for the Mode (208.5 Hz) for the deviate group. This suggests a more restricted bottom frequency range for children with voice problems.

Further comparisons of the groups show that the vocally deviate group has a larger variability (9 Hz) than does the normal group (5 Hz). The deviate group also shows a wider overall Mid-90% range of scores around the f_o (200.4 - 221.1 Hz) than does the normal group (193 - 205 Hz). This trend is also present in the Mid-50% range of scores.

The Skewness (SK) factor was defined as the ratio of the third-moment to the cube of the standard deviation and calculated by the formula $SK = (\varepsilon(x - \bar{x})^3/N)/ (\varepsilon x - \bar{x})^2/N^{3/2}$ as previously described by Horii (1975). As previously noted the vocally deviant children have larger Skewness factors both in CPS (3.93) and semitones (ST) (3.22) by a factor of 3 than do the normal children (CPS (1.25) and ST (0.96)). However, both groups show a positive skewness across all days and times of day.

Since no other ANOV's showed significant differences among Classes or Classes-by-Levels, the next section of the analysis will deal with measures

of central tendency and dispersion of scores for both the normal children and vocally deviant children.

Descriptive Statistics

A review of the descriptive data for the Modal frequency conditions can be seen in Table 5. On the overall average, the deviate group has a lower f_o (231 Hz) than does the normal group (236 Hz). This same general 5Hz difference in favor of the control group is apparent for the Median and Mode values.

Further comparisons of the variability in fundamental frequency may be seen in the Standard Deviation around the mean. Here the deviate group shows a slightly greater value (5.4 Hz) as compared to the normals (4.1 Hz). The Mid-90% range of fundamental frequency shows a decided difference of variability with the more stable values (9 Hz) favoring the control group over the deviate group (15 Hz). The same trend also occurs for the Mid-50% range of scores. The Skewness factor again shows that the vocally deviant children have positive skewness values over five times greater for the sustained production of /a/ than do the normal children. This result is obtained for both values in CPS or in semitones. This wide dispersion of scores points to reasons why a thorough examination of the patient's total vocal range and vocal potential must be taken into account when detailing a rehabilitation program.

The present experiment also considered contextual material (running speech) as well as sustained vowel production in the analysis of vocal frequency differences in normal and vocally deviant children. To that end, several types of material were used. The first was a "memorized" passage (The Pledge of Allegiance) that most children recite each day while saluting the flag. This

passage was chosen to provide a running speech context consistent in linguistic content across subjects.

As can be seen in Table 6, the average mean score across days and times of day does not differ significantly. In fact, the Mean, Median and Mode results for both groups are about 232 Hz, with the deviant group showing a slightly higher standard deviation (41 Hz) than the normal group (36 Hz). It is interesting to note the magnitude of increase in variability as the context changes from sustained vowel (low variability) to running speech (higher variability). With Mid-90% frequency range data, the vocally deviant group of children show a wider range (135 Hz) between the 5th percentile and the 95th percentile as compared to 111 range for the normal group. The Mid-50% range is almost equal, however, for both groups.

In marked contrast to the dispersion of the sustained vowel productions, the contextual, memorized passage shows skewness for both groups in the negative range, with larger (by a factor of three) negative skewing for the semitone values than for the CPS values. This finding is in agreement with those reported by Zemlin (1968) and Horii (1975) for the contextual speech of adults. The skewness values are larger by a factor of six or more than those reported by Horii, a finding to be discussed later.

In order to compare non-memorized material with speech taken in a Free-Field condition, the present experiment examined the fundamental frequency extracted from each child's description of several action pictures. In Table 7, the reader can see that as with the "Pledge" results, the two groups of children have comparable fundamental frequencies. Again, the normal group has an overall higher Mean vocal frequency than the deviant group. While the Median vocal frequency values are similar across groups,

the Mode value is much higher for the deviant group -- a result probably brought about by an abnormal high value for the Tuesday-afternoon session. In this case, it is suggested that a few spurious frequency values may have influenced the computers peak-picking abilities and thus is to be viewed with caution. As in previous contextual data, the Mid-90% range of the vocally deviant children is much larger on the average (163 Hz) than the normal group (106 Hz). Further, as with the "Pledge" data, the amount of fundamental frequency dispersion as indicated by the Skewness factor shows negative skewing for both CPS and ST values, with the ST values being on the order of four times the size of the CPS values. These values are much larger than those reported by Horii (1975).

Many experimental approaches to estimating fundamental frequency have examined only data collected in a laboratory setting. This has led to some criticism of the representativeness of such vocal frequency values when compared to the cold running speech found in other than structured settings, that is, on a playground, at home during play, in an open classroom. In order to examine possible differences in structured and non-structured settings, the experiments attached an FM transmitter to the child's clothing and permitted the child to talk with anyone in the school setting.

As can be seen in Table 8, the data on Free-Field speech taken on one day at one time of day show slightly different trends when compared with the other contextual results. In the Free-Field condition, the vocally deviant children show an overall higher mean vocal fundamental frequency (231 Hz) when compared to the normal group (233 Hz). This higher vocal frequency trend for the vocal nodule children is similar for the Median and Mode values as well. However, the Standard Deviation and Mid-90%, and Mid-50% values show the vocally deviant children to have a larger spread of score with

more individual variation than the normal children. Moreover, the Skewness factor, while still in the negative range shows the normal children in a less negative range (-0.84 CPS; -0.57 ST) than the deviate group (-1.74 CPS; -1.48 ST), a factor to be considered in further research on fundamental frequency distributions from cold running speech situations. Again, however, both groups show differences between CPS and ST dispersions on a magnitude of from two to three times favoring the CPS values.

In comparison to the other contextual (Pledge-Picture) vocal frequency data, the Free-Field sample shows greater variability on the Standard Deviation and Mid-90% range than did the other running speech contexts. The trend toward higher fundamental frequencies for the vocally deviant group suggests several possible factors, including increased vocal effort, increased loudness, and an increased rate of speech. These factors will be considered later in the conclusions section of the report.

1.7 Perceptual Analysis

In an attempt to determine which aspects of vocal behavior relate best to vocal frequency production in children, recordings of the "Pledge of Allegiance" for a one day, one time of day period were selected for judgments of vocal efficiency.

The judgments of voice production were related to 15 dimensions of voice previously described by Darley, et al. (1969). These 15 dimensions included items primarily related to vocal function and are as follows: 1) pitch level, 2) pitch breaks, 3) monopitch, 4) voice tremor, 5) monoloudness, 6) excess loudness variation, 7) loudness decay, 8) alternating loudness, 9) loudness (overall), 10) harsh voice, 11) hoarse voice, 12) breathy voice (continuous), 13) breathy voice (transient), 14) strained-strangled voice, and 15) voice stoppages.

Judgments of the experimental tape containing the voices of 15 normal children and voices of the 15 vocally deviant children with vocal nodules were made by seven graduate students at Oklahoma State University. Each of the judges was clinically trained in the use of the 15 items from coursework in Voice Disorders and Neurological Problems, and from exposure to the meaning of the characteristics through audio training tapes (Aronson, 1973). Further, each judge was experienced in describing perceived voice characteristics of normal and pathological patients from diagnostic practicuum in Speech-Language Pathology. In addition, each judge was provided with a list of the 15 dimensions and the accompanying definition of each term. In addition to these 15 variables, the judges were asked to rate the "severity (vocal efficiency)" of each voice sample.

Each judge was provided with forms upon which to indicate the degree of presence of each of the variables and the overall "vocal efficiency" of each of the samples. The ratings were made on a seven (7) point equal-appearing interval scale, with one (1) being normal vocal production, and seven (7) being very severe abnormal vocal production and four (4) being mid-way between these two end points.

During the listening session, the judges were directed to a quiet room and seated in a semicircle in front of an Acoustic Research, Model AR-3, loudspeaker. Acoustic output from the experimental tape was processed on a Nagra, Model 4.2L tape recorder and fed to the loudspeaker. The judges were allowed to listen to as many repetitions of the recorded samples as they deamed necessary to make their ratings.

For the perceptual analysis, the seven individual listener's judgments on the 16 variables (15 perceptual characteristics, $\bar{X}$, f_o) for the 30 child

speakers were intercorrelated with the rated severity to form a 17 x 17 intercorrelation matrix as presented in Table 9. In this table is presented the rank order of the correlation coefficients (top number) in descending order of magnitude. The bottom number seen for each variable is the probability statement for each coefficient. This matrix was then submitted to a standard stepwise multiple regression analysis to obtain an indication of which factors studied best allow the prediction of the criterion of perceived severity of vocal production.

Results of the multiple regression analysis are summarized in Table 10. Variables included in the final step of the regression equation, their respective regression coefficients and significance levels are provided in this table. Relative to the most efficient predictors of severity, the variables reflected in Table 10 are those to which the addition of other variables would add no significant prediction. For example, in Step 11 of the regression program, the variable Fundamental Frequency was added. The R^2 then equalled 0.778, however, the F = 2.04 with a probability of 0.1552, a level too low to be included in the final summary table. Therefore, the data in Table 10 lists the following major variables which account for the R^2 of 0.776: pitch level, monopitch, loudness decay, alternating loudness, harsh voice, hoarse voice, breathy voice - continuous, breathy voice - transient, strained-strangled voice, and voice stoppages. Severity can be predicted if the variables noted in Table 10 are weighted with their regression coefficients and added to a predetermined constant.

It is interesting to note that the single physical variable used in the present matrix ($\bar{X}$ fundamental frequency) did not become one of the predictor variables. This is not unexpected since none of the fundamental frequency values for the various contexts differentiated the groups, days or times of

day. Further research with the data should include the 10 perceptual variables selected in this study plus physical measurements of Basal frequency, the Standard Deviation of frequency, and Skewness factor.

1.8 Discussion

This experiment was designed to examine vocal frequency differences between normal speaking children and children with vocal nodules and accompanying vocal quality disturbances. The results of the present investigation suggest that only one of the vocal frequency measures studied (Basal Frequency) differentiated the two groups. Other measures of Modal vocal frequency, while showing differences in absolute value, did not statistically differentiate the two groups.

The Basal frequency values for normal school age children (201 Hz) was significantly lower than that of the vocal deviant children (211 Hz). This suggests that normal children have a lower range of vocal frequency than vocal nodule children. Further, the small amount of variability of this measure for the normals suggests a stable base measure from which to estimate total frequency range. The larger amount of variability in the vocal nodule children indicates some difficulty in reaching or maintaining that lowest sustainable tone. It is interesting to note that the absolute frequency data in the present study is about 20 Hz lower than that obtained by Austin and Leeper (1975) for children between nine and ten years of age.

Interestingly, no statistical differences occurred as a function of day of testing (Tuesday - Thursday) or time of day (morning - afternoon) for either group. This finding is in direct opposition to earlier experiments with basal frequency of adults (Cooper and Yanagihara, 1971) and with children (Austin and Leeper, 1975). Both of the earlier studies found significant

differences in Basal frequency levels for both days and times of day. Reasons for the differences in the past results and those of the present investigation are several. First, it should be noted that both Cooper and Yanagihara and Austin and Leeper found greater variability in their female subjects. Since the present study had only four female subjects (two controls - two vocally deviant) it is suggested that the majority of the data in the present study is based upon male variability. In general, Basal frequency in males appears to be smaller than that of females of the same age. This is a finding to be researched further in forthcoming experiments. Secondly, the present data was analyzed with a high quality complex computer system; a technique which does not allow for as much error as those of signal filtering systems used by other researchers (Horii, 1975, Austin and Leeper, 1975). Thus, more stable and sophisticated frequency-picking technique of the computer procedure may have reduced the overall variability. In addition, instructions to the subjects, practice effects, and multiple sampling may have reduced (made more stable) the Basal frequency data in the present study.

As would be predicted, the Basal frequency data for both normal and vocally deviant children differed significantly from the other measures of Modal frequency. This difference was on the order of 20 Hz for both groups. This was true for both sustained vowel productions (Modal Condition) and modal contextual condition ("Pledge", Picture, Free Field). It is interesting to note, however, that the sustained vowel modal condition was the highest vocal frequency (235 Hz) when compared to the sustained vowel Basal Condition (20 Hz) with the "Picture" condition being closest to the Basal frequency in absolute value. Differences in obtaining Basal frequency levels through production of sustained vowels or by monotone production of a contextual passage at the lowest sustainable frequency needs further exploration.

In order to discuss the average modal values for both sustained vowels and contextual vocal output, it is necessary to compare the present modal values to those of previous investigators. In one of the few studies to compare the fundamental frequency values of normal children and children with vocal nodules and accompanying voice deviancy, Leeper and Warr-Leeper (1976) found a non-significant statistical trend which showed higher fundamental frequency for normal children (256 Hz) when compared to vocal nodule children (246 Hz). The amount of variability, however, precluded any firm statements about the effects of mass adding lesions (nodules) on the fundamental frequency of voice production. Further, their techniques (Magnz See and oscillographic) of measurement were more crude than the present experiment. Still in agreement with that data is the fact that the present research found numerical differences in Modal vocal frequency of sustained vowel production favoring the normal children (normal-236 Hz; deviate-231 Hz). Slight differences favoring the normal children were also found with the contextual "Picture" condition of obtaining modal fundamental frequency (normal-229 Hz; deviate-225 Hz). A reversal in this trend was seen in the Free Field contextual frequency condition. Here the vocally deviate children had a higher fundamental frequency (232 Hz) than did the normal children (223 Hz). It is interesting to speculate that in this Free Field condition the vocal nodule reached a higher fundamental frequency by increasing vocal effort, i.e. mean subglottic pressure, thus increasing overall intensity and thereby increasing in frequency (Isshiki, 1964). Since no controls were placed on the child's production, it is suggested that this might have occurred. Anecdotal reports by school teachers and school speech pathologists would support the different mode of phonation used by vocal nodule children during recess or in non-structured

setting as opposed to the classroom setting. A mode of phonation like that just discussed has already been suggested by Leeper (1976) who examined aerodynamic and acoustic variables in children during various voice initiation maneuvers. He found a large amount of air volume expired during hard vocal attacks by vocal nodule children. This output would lead to a sharp acceleration in vocal frequency (higher pitch) and a less stable mechanism with which to do the work of phonation; a condition not unlike what may happen in the Free Field situation.

When comparisons of vocal frequency in the normal children are made with previous studies, (Fairbanks, Wiley, and Lassman, 1949; Fairbanks, Herbert and Hammond, 1949; Eguchi and Hirsh, 1969) it is apparent that the children in the present study have Modal vocal frequencies significantly lower than those in the older studies. On the average, the normal nine year old children in the present study have a vocal frequency of about 230 Hz, while those for the male children in the Fairbanks, Wiley and Lassman (1949) study was about 295 Hz and for female children in the Fairbanks, Herbert, and Hammond (1949) study was about 284 Hz. Even the more recent study of Eguchi and Hirsh (1969) reported values of about 262 Hz for nine and ten year old children. It should be noted, however, that Eguchi and Hirsh (1969) used sustained vowel productions for estimation of fundamental frequency, while Fairbanks and associates used contextual material for phonophoto phonellographic analysis of the fundamental. It should also be noted that the median fundamental frequency values and mode values for fundamental frequency are typically within 2 Hz of the mean for sustained vowels and within 3-4 Hz for contextual speech. If large deviations occurred, it was usually with the vocally deviate groups.

The amount of variability seen in the present frequency measures may be estimated by observing the Standard Deviation of frequency production, the

Mid-90% and Mid-50% range. It should be noted that the variability in the Eguchi and Hirsh (1969) data for sustained vowel production was about 30 Hz for the nine and ten year old children, while variability in the present study for a similar condition was about 4-5 Hz. Obviously differences in the analyzing equipment must be considered here. When comparing the Eguchi and Hirsh (1969) and Leeper and Warr-Leeper (1976) data with that of the contextual sample in the present study, the 30 Hz standard deviation value seems more appropriate. Not unexpectedly, the Free Field data recorded via FM telementry had the largest variability (48 Hz) across both groups.

The range of variability around the mean is expressed by the Mid-90% or Mid-50% range of scores. Previous studies by Fairbanks, Wiley and Lassman (1949) for male children and by Fairbanks, Herbert and Hammond (1949) presented a Mid-90% range averaging about 3.65 musical tones for contextual frequency measures. The normal children in the present study had a Mid-90% range of about 4.4 musical tones for the Pledge-Picture situation and about 7 musical tones for the Free Field situation. The vocally deviate children, however, were more variable than the normals, having Mid-90% ranges of about 5.5 tones for the Picture condition and a Free Field range of 8 musical tones. Thus, for the recitation passages the data of the present study support Fairbanks and Associates view that children use a rather monotonous voice for oral reading or recitation and a more variable voice for non-structured speaking situations. The Mid-90% ranges of scores for the Basal frequency were about .5 musical tones for both normal and deviate subgroups. The Mid-50% range shows less variability across and within subgroups studied in the present experiment than the Mid-90% range.

As a further extension of the study of vocal frequency variability, a measure of skewness of the fundamental frequency distribution was analyzed (Horii, 1975). Analysis of the present data for children indicated a

positively skewed distribution for the Basal frequency and Mode frequency conditions for groups (normal - vocally deviate) and for measures of Skewness (CPS and Semitones). For Basal frequency, the positive skewness was three times higher for the vocally deviate children (+3.93 CPS) than the normals (+1.26 CPS), as well as for the semitone (ST) values (normal +0.96 ST - deviates +3.22 ST). The Modal sustained vowel condition shows a similar pattern with deviates having larger values (+1.58 CPS - 1.20 ST) than normals (+0.34 CPS - +0.13 ST) when contextual frequency conditions are considered, the distributions become negative across all conditions and subgroups. Further, the Skewness (CPS) value is less negative than the semitones (ST) value for each condition and group under the running speech condition are -0.51 (Picture) to -0.85 (Free Field). For the deviate group under the same conditions, CPS values run from -0.46 (Picture) to -0.57 (Free Field). A similar condition is present for the normals for the semitones variable where a range of from -1.74 ST [Free Field to -2.08 ST (Picture)] was obtained. The deviate group had scores from -1.48 ST (Free Field) to -1.92 ST (Picture). It is interesting to note that with the running speech condition, the vocally deviant group had scores that were always less than the normal control group.

Since no other data for skewness of the fundamental frequency distribution is available for children, the experimenters must relate the present findings to data obtained for adults. Horii (1975) determined that for 65 adult males, a positive mean skewness of 0.40 for CPS values and a negative skewness -0.12 for ST values was most representative. His data was supported by a Russian scientist (Mikheev, 1971) who found a generally positive distribution of telephone conversations for adult males and females. Zemlin (1968)

on the other hand suggested that most f_o distributions are negatively skewed, a finding in concert with a majority of the data for contextual speech in the present study. While the current data show large variations in skewness and are not in agreement with data for adults, it is suggested that differences in one method of producing fundamental frequency, i.e., sustained vowel versus cold running speech, has a differential effect on the skewness of that distribution.

It is also suggested that the negative skewness found in the running speech segment of the experiment indicates that the talkers were using primarily declarative sentences or were showed a tendency to use falling intonation patterns. Conversely, during sustained vowel phonation, the bulk of the distribution was around the mean, with other frequency values higher than the mean, thus presenting a positive distribution pattern. Further research is needed employing a melody plot of the speech to confirm these preliminary findings with children.

The second part of the experiment related 15 perceptual factors and one physical variable to the ratings of overall vocal efficiency. The results of the present study allow for a number of speculative observations about the relation of severity of voice and the mechanism for voice production.

In general, the results suggest that listeners can accurately scale voices along a severity continuum and relate this to judged voice characteristics. It seems that the process of developing mass adding lesions leads to characteristics of the voice which relate to a loss of vocal efficiency.

The primary direction of this preliminary analysis was to use trained listeners' judgments and one acoustic measurement to study the severity of voice production. The major finding that the variable of mean fundamental frequency was of little value in predicting perceived severity is of special

interest. First, it may be that in conjunction with measures of frequency variability and skewness this variable could account for some higher correlation in the overall prediction of severity. Secondly, it may be that unless the vocal frequency is so variable as to draw attention to itself, it is not used exclusively by listeners in making judgments of overall severity. The use of mean fundamental frequency as a "high" predictor variable has also been questioned by Mysak (1959) and Ryan and Burk (1974) in their studies of perceived age characteristics of the voice.

From the present perceptual data it may be reasoned that perceptual variables are more valuable in describing voice disorders than are selected vocal frequency measures. This view has been championed by Darley, Aronson, and Brown (1969) and by Wilson (1971). To the contrary, it may be that only by further searching for more specific acoustic and aerodynamic measures can experimenters hope to make studies in determining the boundaries for normal and abnormal voice production (Leeper, 1976; Michel, 1977).

Special reference should be made to the 10 voice characteristics which best predict severity. Of those variables, only two, pitch level and monopitch, have a physical counterpart in the matrix - mean fundamental frequency. Most of the remaining factors, loudness decay, alternating loudness, harsh voice, hoarse voice, breathy voice - continuous and transient, strained-strangled voice and voice stoppages all seem to point to a strong alteration of air flow and/or medial compression in conjunction with increased severity. Of course, the investigators are basing the assumption of physiological integrity on the listener's ability to identify the perceptual characteristics that truly reflect the condition of the vocal folds.

A possible explanation for the high predictive value of breathy voice, strained-strangled voice and voice stoppages as well as hoarse, harsh voice and loudness factors is that each of these characteristics has been used previously to describe voices associated with mass adding lesions. When bilateral nodules exist on the folds, air is lost during phonation, intensity is increased to try and overcome the loss of efficiency, and the resultant hard attack re-initiates the vicious cycle of laryngeal abuse (Leeper, 1976).

The findings of Darley, Aronson, and Brown (1969) and Spencer and Leeper (1972) suggest that perceptual correlates of physiological activity can be used to describe certain types of communicatively involved patients. It should be remembered that the predictor variables obtained in the present study are valid only when they can be used to predict the severity of voice production of children with voice disorders in subsequent independent investigations. The implications for further research are numerous. Initially, a larger number of physical variables need to be included in the correlation matrix. In addition, a wider range of laryngeal problems of children need to be included in the perceptual analysis. Further, correlations between perceptual scales for teaching voice scaling (Wilson, 1971) and perceptual variables (Darley, Aronson and Brown, 1969) physilogical bases should be obtained.

1.9 Clinical Implications

The results of the present study suggest that the speech pathologist in a clinical setting should use Basal frequency measures to determine baseline data for changes in voice production as a result of voice management. Further, while Modal vocal frequency data for both sustained and contextual speech

do not differentiate normal and vocal nodule children, the small variability in sustained vowel productions suggest its usefulness for beginning steps in therapy. In fact, one such behavior management program (Voice Adequacy/Action Management Program, Leeper, 1977) is based on the premise of increasing the "phonetic" load on the laryngeal system with increases in adequate voice production. Finally, the present data suggest that listener judgments of vocal characteristics have a valid base in the training of clinical speech-language pathologists in the public schools and other direct patient care situations.

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TABLE 1. Summary of Analysis of Variance Procedure for Evaluation of Differences Between Classification, Stimuli, Day and Time of Day for the Vocal Frequency of Production

VOCAL FREQUENCY MEASURES IN NORMAL SPEAKING CHILDREN AND CHILDREN WITH VOCAL DEVIATIONS — 41

17:58 TUESDAY, SEPTEMBER 20, 1977

FULL RANGE CONDITIONS

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: TESTMEAN

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	33	65684.60408618	1990.44254807	3.01	0.0001	0.172252	11.4560
ERROR	477	315644.18077046	661.72784229		STD DEV		TESTMEAN MEAN
CORRECTED TOTAL	510	381328.78485664			25.72407126		224.54605049

SOURCE	DF	ANOVA SS	F VALUE	PR > F
STIMULI	4	57234.06407692	21.62	0.0001
CLASSIFY	1	175.83842419	0.27	0.6065
STIMULI*CLASSIFY	4	4346.46885119	1.64	0.1625
DAY	1	2.93598877	0.00	0.9469
STIMULI*DAY	3	211.53536275	0.11	0.9515
CLASSIFY*DAY	1	1.14779152	0.00	0.9668
STIMULI*CLASSIFY*DAY	3	130.25612182	0.07	0.9726
TIME	1	1471.45973893	2.22	0.1366
STIMULI*TIME	3	597.62350399	0.30	0.8262
CLASSIFY*TIME	1	0.00000000	0.00	1.0000
STIMULI*CLASSIF*TIME	3	192.09958343	0.10	0.9568
DAY*TIME	1	0.00000000	0.00	1.0000
STIMULI*DAY*TIME	3	1012.97083840	0.51	0.6795
CLASSIFY*DAY*TIME	1	64.98040202	0.10	0.7541
STIMU*CLASS*DAY*TIME	3	247.69931528	0.12	0.9413

TABLE 2. Duncan's Multiple Range Test of Mean Vocal Frequency Differences Attributable to Varying Stimuli

VOCAL FREQUENCY MEASURES IN NORMAL SPEAKING CHILDREN AND CHILDREN WITH VOCAL DEVIATIONS 42

17:58 TUESDAY, SEPTEMBER 20, 1977

FULL RANGE CONDITIONS

DUNCAN'S MULTIPLE RANGE TEST FOR VARIABLE TESTMEAN

MEANS WITH THE SAME LETTER ARE NOT SIGNIFICANTLY DIFFERENT.

ALPHA LEVEL=.05 DF=33 MS=1990.44

GROUPING	MEAN	N	STIMULI
A	233.586431	120	MODAL FREQUENCY
A			
A	231.533793	120	PLEDGE
A			
A	227.452260	30	FREE FIELD
A			
A	226.252681	121	PICTURE
B	206.070522	120	BASAL FREQUENCY

TABLE 3. Summary of Analysis of Variance for Evaluation of Differences Between Groups, Day, and Time of Day for the Basal Frequency of Phonation

VOCAL FREQUENCY MEASURES IN NURMAL SPEAKING CHILDREN AND CHILDREN WITH VOCAL DEVIATIONS — 15

17:58 TUESDAY, SEPTEMBER 20, 1977

BASAL FREQUENCY STIMULI

ANALYSIS OF VARIANCE PROCEDURE

DEPENDENT VARIABLE: TESTMEAN

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	7	3850.44468613	550.06352659	0.93	0.4890	0.054797	11.8171
ERRCR	112	66416.38831084	593.00346706		STD DEV		TESTMEAN MEAN
CORRECTED TOTAL	119	70266.83299698			24.35166251		206.07052250

SOURCE	DF	ANOVA SS	F VALUE	PR > F
CLASSIFY	1	3080.65797460	5.20	0.0245
DAY	1	65.30076143	0.11	0.7406
CLASSIFY*CAY	1	21.55946936	0.04	0.8491
TIME	1	44.24241360	0.07	0.7852
CLASSIFY*TIME	1	23.36198131	0.04	0.8430
CAY*TIME	1	401.71319691	0.68	0.4122
CLASSIFY*DAY*TIME	1	213.60888892	0.36	0.5496

TABLE 4. Summary of Descriptive Data for Basal Frequency Including Mean, Median, Mode, Standard Deviation, 90% range, 50% range and Skewness in CPS and Semitones for the Normal and Vocally Deviant Children

BASAL FREQUENCY STIMULI
CLASSIFY=NORMAL DAY=TUESDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALJE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	202.82672000	13.76218835	178.90760000	228.56640000	3.55338175	3042.4008000	189.3978282	6.785
TEST_SD	15	5.82186667	4.35524800	2.18580000	18.49660000	1.12452020	87.3280000	18.9681852	74.808
TEST_MED	15	201.12786667	13.92383444	175.76360000	227.06000000	3.59511859	3016.9180000	193.8731655	6.923
TESTMODE	15	188.60000000	48.53540681	21.00000000	228.00000000	12.53178815	2829.0000000	2355.6857143	25.735
C5RANGE	15	195.70133333	15.30884612	170.02000000	222.90000000	3.95272707	2935.5200000	234.3607695	7.823
C95RANGE	15	210.83333333	13.86637866	187.68000000	231.96000000	3.58041267	3162.5000000	192.2903238	6.577
C25RANGE	15	198.68133333	14.15484060	172.14000000	225.62000000	3.65476413	2980.2200000	200.3595124	7.124
C75RANGE	15	203.88933333	14.04637394	179.52000000	230.46000000	3.62675816	3058.3400000	197.3006210	6.889
SKEW_CPS	15	1.50533333	3.20488883	-1.50000000	9.99000000	0.82749874	22.5800000	10.2713124	212.902
SKEWTONE	15	1.22400000	3.17419686	-1.73000000	9.94000000	0.81957411	18.3600000	10.0755257	259.330

CLASSIFY=NORMAL DAY=TUESDAY TIME=AFTERNOON

TESTMEAN	15	201.50388000	18.66748830	174.36000000	246.88020000	4.81992475	3022.5582000	348.47511952	9.264
TEST_SD	15	5.23638000	2.53025899	2.56320000	10.14840000	0.65331006	78.5457000	6.40221054	48.321
TEST_MED	15	200.44165333	18.85944124	173.06040000	248.00980000	4.86946679	3006.6248000	355.67852389	9.409
TESTMODE	15	201.73333333	19.43291268	172.00000000	250.00000000	5.01755648	3026.0000000	377.63809524	9.633
C5RANGE	15	192.79600000	16.94768623	165.64000000	231.76000000	4.37587377	2891.9400000	287.22406857	8.790
C95RANGE	15	209.25866667	22.44938748	178.24000000	268.36000000	5.79640692	3138.8800000	503.97499810	10.728
C25RANCE	15	196.93066667	17.79903828	171.26000000	239.18000000	4.59569192	2953.9600000	316.80576381	9.038
C75RANGE	15	203.85866667	19.25428556	175.30000000	250.02000000	4.97143515	3057.8800000	370.72751238	9.445
SKEW_CPS	15	1.08466667	1.36342461	-1.54000000	4.72000000	0.35203472	16.2700000	1.85892667	125.700
SKEWTONE	15	0.80800000	1.36674901	-1.70000000	4.51000000	0.35289308	12.1200000	1.86800286	169.152

CLASSIFY=NORMAL DAY=THURSDAY TIME=MORNING

TESTMEAN	15	199.51272000	17.03051000	170.75380000	221.15400000	4.39725877	2992.6908000	290.038271	8.536
TEST_SD	15	4.39930667	1.36200168	1.59940000	7.13640000	0.35166732	65.9896000	1.855049	30.959
TEST_MED	15	198.43462667	17.28949391	169.95700000	221.21320000	4.46412813	2976.5194000	298.926600	8.713
TESTMODE	15	199.73333333	17.13587159	172.00000000	222.00000000	4.42446302	2996.0000000	293.636095	8.579
C5RANCE	15	191.83866667	16.92892279	162.00000000	212.46000000	4.37102907	2877.5800000	286.588427	8.825
C95RANGE	15	193.53066667	50.89448237	19.82000000	226.74000000	13.14089884	2902.9600000	2590.248335	26.298
C25RANGE	15	224.35733333	110.36955270	167.02000000	618.56000000	28.49729597	3365.3600000	12181.436164	49.194
C75RANGE	15	200.90666667	17.08294499	171.52000000	223.60000000	4.41079743	3013.6000000	291.827010	8.503
SKEW_CPS	15	1.30466667	3.20765795	-4.90000000	8.71000000	0.82821372	19.5700000	10.289070	245.860
SKEWTONE	15	0.89333333	3.03246874	-5.47000000	7.45000000	0.78298006	13.4000000	9.195867	339.455

CLASSIFY=NORMAL DAY=THURSDAY TIME=AFTERNOON

TESTMEAN	15	200.17169333	19.25172405	167.24740000	231.23240000	4.97077378	3002.5754000	370.62887904	9.618
TEST_SD	15	4.52316000	1.60634938	2.34060000	8.10400000	0.41475763	67.8474000	2.58035834	35.514
TEST_MED	15	199.30728000	19.03466579	166.65160000	230.43960000	4.91472957	2989.6092000	362.31850159	9.550
TESTMODE	15	200.13333333	18.96563308	168.00000000	228.00000000	4.89690540	3002.0000000	359.69523810	9.476
C5RANGE	15	192.31333333	19.15633079	160.04000000	223.58000000	4.94614334	2884.7000000	366.96500952	9.961
C95RANGE	15	206.87466667	20.45867398	171.74000000	238.38000000	5.28240691	3103.1200000	418.55734095	9.889
C25RANCE	15	196.23333333	18.90318441	163.68000000	226.50000000	4.88078123	2943.5000000	357.33038095	9.633
C75RANGE	15	201.75466667	19.47032096	168.28000000	232.72000000	5.02721525	3026.3200000	379.09339810	9.650
SKEW_CPS	15	1.14333333	2.07259901	-1.71000000	7.29000000	0.53514276	17.1500000	4.29566667	181.277
SKEWTONE	15	0.92266667	2.01425089	-1.92000000	6.85000000	0.52007734	13.8400000	4.05720667	218.308

TABLE 4. Continued

BASAL FREQUENCY STIMULI

CLASSIFY=DEVIATE DAY=TUESDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	215.66337333	28.60053919	167.40760000	257.72660000	7.38462746	3234.9506000	817.9908419	13.262
TEST_SD	15	7.07507333	4.64309708	2.66460000	18.06870000	1.19884251	106.1261000	21.5583505	65.626
TEST_MED	15	209.60468000	31.79396427	159.78940000	256.48380000	8.20916628	3144.0612000	1010.8561643	15.169
TESTMODE	15	210.26666667	31.76580971	160.00000000	258.00000000	8.20189680	3154.0000000	1009.0666667	15.107
C5RANGE	15	202.92133333	30.71358421	158.18000000	248.50000000	7.93021334	3043.8200000	943.3242552	15.136
C95RANGE	15	224.52400000	27.89944413	171.18000000	265.56000000	7.20360550	3367.8600000	778.3789829	12.426
C25RANGE	15	206.84666667	31.34608261	158.90000000	254.30000000	8.09352373	3102.7000000	982.5768952	15.154
C75RANGE	15	212.90000000	32.60042331	161.86000000	260.74000000	8.41739310	3193.5000000	1062.7876000	15.313
SKEW_CPS	15	1.74933333	2.73357031	-0.69000000	8.80000000	0.70580482	26.2400000	7.4724067	156.264
SKEWTONE	15	1.44666667	2.49372832	-0.88000000	8.07000000	0.64387788	21.7000000	6.2186810	172.378

CLASSIFY=DEVIATE DAY=TUESDAY TIME=AFTERNOON

TESTMEAN	15	207.23834000	25.95909143	171.14780000	244.74180000	6.70260859	3108.5826000	673.8744278	12.526
TEST_SD	15	8.59764000	7.95274137	2.64380000	32.97360000	2.05338899	128.9646000	63.2460953	92.499
TEST_MED	15	204.51913333	25.28236927	167.85440000	240.91240000	6.52787968	3067.7870000	639.1981961	12.362
TESTMODE	15	205.06666667	25.03559371	168.00000000	242.00000000	6.46416250	3076.0000000	626.7609524	12.209
C5RANGE	15	197.99333333	25.11254401	161.28000000	238.00000000	6.48403098	2969.9000000	630.6398667	12.684
C95RANGE	15	219.29466667	36.11208936	179.46000000	305.90000000	9.32410138	3289.4200000	1304.0829981	16.467
C25RANGE	15	201.98133333	25.10052187	165.80000000	239.40000000	6.48092688	3029.7200000	630.0361981	12.427
C75RANGE	15	208.04533333	25.64642829	171.50000000	244.74000000	6.62187931	3120.6800000	657.7392838	12.327
SKEW_CPS	15	4.40666667	7.26073950	-2.53000000	20.80000000	1.87471488	66.1000000	52.7183381	164.767
SKEWTONE	15	3.63866667	6.14345629	-2.74000000	18.00000000	1.58623359	54.5800000	37.7420552	168.838

CLASSIFY=DEVIATE DAY=THURSDAY TIME=MORNING

TESTMEAN	15	208.70806000	30.16426973	163.60500000	280.57140000	7.78838095	3130.6209000	909.8831681	14.453
TEST_SD	15	14.50520000	17.61796356	1.99940000	67.39780000	4.54893863	217.5780000	310.3926399	121.460
TEST_MED	15	206.03459333	29.71863722	160.82220000	269.50000000	7.67331914	3090.5189000	883.1573985	14.424
TESTMODE	15	206.06666667	30.41256006	160.00000000	270.00000000	7.85248924	3091.0000000	924.9238095	14.759
C5RANGE	15	196.59533333	29.00584445	158.26000000	260.02000000	7.48927683	2948.9300000	841.3350124	14.754
C95RANGE	15	221.54333333	38.41522646	167.02000000	331.80000000	9.91876882	3323.1500000	1475.7296238	17.340
C25RANCE	15	202.67200000	29.11737900	159.30000000	264.50000000	7.51807493	3040.0800000	847.8217600	14.367
C75RANGE	15	210.32000000	30.94740977	163.34000000	283.84000000	7.99058684	3154.8000000	957.7421714	14.714
SKEW_CPS	15	8.00533333	12.28945475	-0.26000000	44.30000000	3.17312357	120.0800000	151.0306981	153.516
SKEWTONE	15	6.61133333	10.59780359	-1.53000000	37.20000000	2.73634112	99.1700000	112.3134410	160.298

CLASSIFY=DEVIATE DAY=THURSDAY TIME=AFTERNOON

TESTMEAN	15	212.93889333	33.81921349	160.00000000	280.46320000	8.73208338	3194.0834000	1143.7392011	15.882
TEST_SD	15	5.31366667	3.56231027	0.10000000	15.51000000	0.91978456	79.7050000	12.6900544	67.041
TEST_MED	15	211.74206667	33.96052471	158.00000000	279.14120000	8.76856978	3176.1310000	1153.3172385	16.039
TESTMODE	15	212.66666667	34.20665488	160.00000000	280.00000000	8.83212031	3190.0000000	1170.0952381	16.085
C5RANGE	15	204.05200000	32.89743177	158.10000000	274.08000000	8.49408036	3060.7800000	1082.2410171	16.122
C95RANGE	15	219.14933333	35.26068784	159.90000000	287.04000000	9.10427045	3287.2400000	1243.3161067	16.090
C25RANGE	15	209.15333333	33.23305297	158.50000000	275.78000000	8.58073738	3137.3000000	1104.4358095	15.889
C75RANGE	15	214.37600000	34.33422882	159.50000000	282.70000000	8.86505976	3215.6400000	1178.8392686	16.016
SKEW_CPS	15	1.56333333	2.47571250	-2.87000000	7.61000000	0.63922622	23.4500000	6.1291524	158.361
SKEWTONE	15	1.20266667	2.15734449	-3.21000000	5.98000000	0.55702395	18.0400000	4.6541352	179.380

TABLE 5. Summary of Descriptive Data for Modal Frequency Including Mean, Median, Mode, Standard Deviation, 90% Range, 50% Range, and Skewness in CPS and Semitones for the Normal and Vocally Deviant Children

MODAL FREQUENCY STIMULI
CLASSIFY=NORMAL DAY=TUESDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	231.86890667	15.32521316	217.65180000	274.78620000	3.95695302	3478.0336000	234.86215830	6.609
TEST_SD	15	4.73520000	1.88015027	3.04200000	9.53020000	0.48545271	71.0292000	3.53496502	39.705
TEST_MED	15	230.65666667	15.39294487	213.85540000	274.21980000	3.97444127	3459.8500000	236.94275170	6.674
TESTMODE	15	231.46666667	15.64730313	212.00000000	276.00000000	4.04011630	3472.0000000	244.83809524	6.760
C5RANGE	15	223.98000000	15.55763845	204.54000000	268.30000000	4.01696498	3359.7000000	242.04011429	6.946
C95RANGE	15	239.12533333	16.14346124	223.18000000	282.30000000	4.16822377	3586.8800000	260.61134095	6.751
C25RANGE	15	227.87200000	15.26082529	211.08000000	270.70000000	3.94032815	3418.0800000	232.89278857	6.697
C75RANGE	15	233.53600000	15.42467448	217.76000000	275.70000000	3.98263383	3503.0400000	237.92058286	6.605
SKEW_CPS	15	0.08133333	2.36351393	-7.20000000	2.77000000	0.61025667	1.2200000	5.58619810	2905.960
SKEWTONE	15	-0.18066667	2.48833124	-8.14000000	2.20000000	0.64248436	-2.7100000	6.19179238	-1377.305

CLASSIFY=NORMAL DAY=TUESDAY TIME=AFTERNOON

TESTMEAN	15	238.21716667	17.67395282	211.34160000	283.70880000	4.56339499	3573.2575000	312.36860811	7.419
TEST_SD	15	3.70252000	1.07156757	2.01220000	6.38280000	0.27667756	55.5378000	1.14825705	28.942
TEST_MED	15	237.01085333	17.62775464	210.39540000	282.84740000	4.55146668	3555.1628000	310.73773364	7.438
TESTMODE	15	238.26666667	17.58029200	212.00000000	284.00000000	4.53921187	3574.0000000	309.06666667	7.378
C5RANCE	15	230.24800000	17.38053229	206.68000000	278.26000000	4.48763414	3453.7200000	302.08290286	7.549
C95RANGE	15	243.28133333	17.84430676	213.76000000	287.62000000	4.60738019	3649.2200000	318.41928381	7.335
C25RANGE	15	235.25200000	17.98883749	208.90000000	282.02000000	4.64469787	3528.7800000	323.59827429	7.647
C75RANGE	15	239.38000000	17.68931558	211.66000000	283.68000000	4.56736164	3590.7000000	312.91188571	7.390
SKEW_CPS	15	0.34866667	1.98421221	-3.85000000	3.07000000	0.51232139	5.2300000	3.93709810	569.086
SKEWTONE	15	0.12200000	2.04874944	-4.37000000	2.52000000	0.52898483	1.8300000	4.19737429	1679.303

CLASSIFY=NORMAL DAY=THURSDAY TIME=MORNING

TESTMEAN	15	237.27720000	19.79020526	209.41540000	281.46440000	5.10980902	3559.1580000	391.65222404	8.341
TEST_SD	15	4.30606667	1.75359118	2.44560000	10.10500000	0.45277530	64.5910000	3.07508203	40.724
TEST_MED	15	236.30408000	19.76403926	208.06460000	279.62000000	5.10305299	3544.5612000	390.61724783	8.364
TESTMODE	15	236.93333333	19.65221422	208.00000000	280.00000000	5.07417989	3554.0000000	386.20952381	8.294
C5RANGE	15	229.04533333	19.73112330	204.02000000	274.40000000	5.09455413	3435.6800000	389.31722667	8.615
C95RANGE	15	243.20800000	20.34931912	213.02000000	287.30000000	5.25417160	3648.1200000	414.09478857	8.367
C25RANCE	15	233.99866667	19.75810353	206.54000000	278.34000000	5.10152040	3509.9800000	390.38265524	8.444
C75RANGE	15	238.80266667	20.15445341	209.70000000	283.14000000	5.20385749	3582.0400000	406.20199238	8.440
SKEW_CPS	15	0.47866667	2.27049040	-2.88000000	6.04000000	0.58623810	7.1800000	5.15512667	474.336
SKEWTONE	15	0.28600000	2.17439253	-3.06000000	5.47000000	0.56142574	4.2900000	4.72798286	760.277

CLASSIFY=NORMAL DAY=THURSDAY TIME=AFTERNOON

TESTMEAN	15	237.05354667	25.15333426	190.99280000	285.90900000	6.49456298	3555.6032000	632.69022432	10.611
TEST_SD	15	3.44865333	1.02383741	2.19720000	5.65920000	0.26435368	51.7298000	1.04824304	29.688
TEST_MED	15	235.82196000	24.91944052	190.18180000	283.90400000	6.43417188	3537.3294000	620.97851577	10.567
TESTMODE	15	236.26666667	24.71398293	192.00000000	284.00000000	6.38112295	3544.0000000	610.78095238	10.460
C5RANGE	15	230.32933333	25.38109518	183.96000000	279.24000000	6.55337060	3454.9400000	644.19999238	11.019
C95RANGE	15	240.95066667	24.54962539	195.24000000	288.00000000	6.33868602	3614.2600000	602.68410667	10.189
C25RANGE	15	233.85600000	25.05121976	188.18000000	282.78000000	6.46819713	3507.8400000	627.56361143	10.712
C75RANGE	15	238.44400000	25.16323985	191.98000000	287.06000000	6.49712059	3576.6600000	633.18864000	10.553
SKEW_CPS	15	0.47000000	1.31685231	-2.42000000	2.31000000	0.34000980	7.0500000	1.73410000	280.181
SKEWTONE	15	0.29600000	1.29474101	-2.58000000	2.01000000	0.33430069	4.4400000	1.67635429	437.413

TABLE 5. Continued

MODAL FREQUENCY STIMULI

CLASSIFY=DEVIATE DAY=TUESDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	228.35709333	25.13613015	172.77040000	267.03680000	6.49012090	3425.3564000	631.82503899	11.007
TEST_SD	15	5.36982667	1.78047753	2.91200000	8.55520000	0.45971732	80.5474000	3.17010023	33.157
TEST_MED	15	227.57522667	25.37752538	171.32560000	265.79720000	6.55244888	3413.6284000	644.01879418	11.151
TESTMODE	15	229.20000000	25.59910713	172.00000000	270.00000000	6.60966104	3438.0000000	655.31428571	11.169
C5RANGE	15	218.69200000	24.92779607	167.14000000	260.00000000	6.43632927	3280.3800000	621.39501714	11.399
C95RANGE	15	235.70800000	24.88091500	177.36000000	271.24000000	6.42422463	3535.6200000	619.05993143	10.556
C25RANGE	15	223.96266667	25.68085208	170.18000000	264.14000000	6.63076750	3359.4400000	659.50616381	11.467
C75RANGE	15	230.93466667	25.53102814	173.46000000	269.22000000	6.59208312	3464.0200000	651.83339810	11.056
SKEW_CPS	15	-0.04733333	1.93345903	-2.55000000	5.99000000	0.49921697	-0.7100000	3.73826381	-4084.773
SKEWTONE	15	-0.21533333	1.92193677	-2.76000000	5.67000000	0.49624194	-3.2300000	3.69384095	-892.540

CLASSIFY=DEVIATE DAY=TUESDAY TIME=AFTERNOON

TESTMEAN	15	234.32038667	29.47130299	188.64420000	289.22900000	7.60945771	3514.8058000	868.55769997	12.577
TEST_SD	15	5.74241333	3.58000693	2.69340000	17.25920000	0.92435382	86.1362000	12.81644964	62.343
TEST_MED	15	232.83981333	29.24920094	187.62720000	287.16820000	7.55211121	3492.5972000	855.51575577	12.562
TESTMODE	15	233.73333333	29.22686305	188.00000000	288.00000000	7.54634359	3506.0000000	854.20952381	12.504
C5RANGE	15	226.02266667	28.18835815	183.42000000	278.98000000	7.27820278	3390.3400000	794.58353524	12.471
C95RANGE	15	240.35600000	30.19020674	191.52000000	297.20000000	7.79507786	3605.9400000	911.44656286	12.559
C25RANGE	15	230.39466667	29.01003222	186.30000000	283.74000000	7.49035811	3455.9200000	841.58196952	12.591
C75RANGE	15	235.88400000	30.01259850	189.16000000	292.68000000	7.74921961	3538.2600000	900.75606357	12.723
SKEW_CPS	15	3.36600000	5.81334524	-0.85000000	21.10000000	1.50099929	50.4900000	33.79498286	172.708
SKEWTONE	15	2.81733333	5.34194516	-0.98000000	19.40000000	1.37928431	42.2600000	28.53637810	189.610

CLASSIFY=DEVIATE DAY=THURSDAY TIME=MORNING

TESTMEAN	15	228.24232000	27.24160109	172.53560000	274.40500000	7.03375116	3423.6348000	742.10482992	11.935
TEST_SD	15	5.66428000	4.23420875	2.42740000	19.50920000	1.09326800	84.9642000	17.92852377	74.753
TEST_MED	15	227.01202667	27.44513576	170.85980000	271.96760000	7.08630358	3405.1924000	753.23547670	12.090
TESTMODE	15	227.73333333	26.89521112	172.00000000	272.00000000	6.94431365	3416.0000000	723.35238095	11.810
C5RANGE	15	220.26400000	27.26573381	166.60000000	268.52000000	7.03998220	3303.9600000	743.42024000	12.379
C95RANGE	15	234.70400000	27.73483957	179.12000000	279.52000000	7.16110478	3520.5600000	769.22132571	11.817
C25RANGE	15	224.58666667	27.36785045	169.08000000	270.68000000	7.06634860	3368.8000000	748.99923810	12.186
C75RANGE	15	229.41733333	27.69413024	172.40000000	275.28000000	7.15059368	3441.2600000	766.96484952	12.072
SKEW_CPS	15	0.96666667	2.56701235	-2.83000000	7.02000000	0.66279974	14.5000000	6.58955238	265.553
SKEWTONE	15	0.65533333	2.50667927	-3.47000000	6.19000000	0.64722180	9.8300000	6.28344095	382.504

CLASSIFY=DEVIATE DAY=THURSDAY TIME=AFTERNOON

TESTMEAN	15	233.35482667	31.21511872	160.60460000	283.06920000	8.05970900	3500.3224000	974.3836366	13.377
TEST_SD	15	4.70446667	2.03676749	1.52720000	8.78100000	0.52589110	70.5670000	4.1484218	43.294
TEST_MED	15	232.37841333	31.57327185	159.22860000	282.57700000	8.15216374	3485.6762000	996.8714953	13.587
TESTMODE	15	233.20000000	31.68415557	160.00000000	284.00000000	8.18081379	3498.0000000	1003.8857143	13.587
C5RANGE	15	226.28666667	30.10970291	158.12000000	275.42000000	7.77429186	3394.3000000	906.5942095	13.306
C95RANGE	15	240.51866667	31.34204795	162.84000000	287.62000000	8.09248198	3607.7800000	982.3239695	13.031
C25RANGE	15	229.57333333	30.88584203	158.62000000	279.22000000	7.97469012	3443.6000000	953.9352381	13.454
C75RANGE	15	234.52800000	31.94798880	159.84000000	283.64000000	8.24893524	3517.9200000	1020.6739886	13.622
SKEW_CPS	15	2.04133333	4.32306582	-7.74000000	12.30000000	1.11621080	30.6200000	18.6888981	211.777
SKEWTONE	15	1.55800000	4.01549357	-8.81000000	9.26000000	1.03679598	23.3700000	16.1241886	257.734

TABLE 6. Summary of Descriptive Data for Contextual (Pledge of Allegiance) Fundamental Frequency Data Including Mean, Median, Mode, Standard Deviation, 90% Range, 50% Range, and Skewness in CPS and Semitones for the Normal and Vocally Deviant Children

PLEDGE STIMULI
CLASSIFY=NORMAL DAY=TUESDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	229.47027333	21.19731824	189.00620000	260.22280000	5.47312403	3442.1741000	449.3263004	9.237
TEST_SD	15	36.84372000	10.93279421	19.57540000	56.78790000	2.82283533	552.6558000	119.5259892	29.673
TEST_MED	15	229.32163333	20.18361924	191.01120000	255.30100000	5.21138808	3439.8245000	407.3784855	8.801
TESTMODE	15	228.73333333	21.65464868	185.00000000	250.00000000	5.59120625	3431.0000000	468.9238095	9.467
C5RANGE	15	165.21400000	38.52242794	104.72000000	211.65000000	9.94644812	2478.2100000	1483.9774543	23.317
C95RANGE	15	278.27533333	31.61507594	216.89000000	332.50000000	8.16297751	4174.1300000	999.5130267	11.361
C25RANGE	15	215.13000000	17.60379829	180.82000000	231.78000000	4.54528117	3226.9500000	309.8937143	8.183
C75RANGE	15	247.09066667	24.96027572	199.42000000	284.38000000	6.44471548	3706.3600000	623.0153638	10.102
SKEW_CPS	15	-0.13266667	1.81354218	-2.55000000	3.82000000	0.46825458	-1.9900000	3.2889352	-1366.992
SKEWTONE	15	-1.79733333	1.13108966	-3.66000000	-0.12000000	0.29204609	-26.9600000	1.2793638	-62.932

CLASSIFY=NORMAL DAY=TUESDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	235.00850000	20.76962160	197.27420000	274.95610000	5.36269324	3525.1275000	431.3771814	8.838
TEST_SD	15	35.95414000	6.83980776	23.75900000	47.72470000	1.76603077	539.3121000	46.7829702	19.024
TEST_MED	15	235.31712667	20.74354334	199.39670000	276.20830000	5.35535986	3529.7569000	430.2545905	8.815
TESTMODE	15	233.86666667	24.33065869	200.00000000	277.00000000	6.28214906	3508.0000000	591.9809524	10.404
C5RANGE	15	172.94333333	39.27250868	97.61000000	216.12000000	10.14011814	2594.1500000	1542.3299381	22.708
C95RANGE	15	283.97266667	26.87686963	237.74000000	343.62000000	6.93957790	4259.5900000	722.3661210	9.465
C25RANGE	15	221.26600000	18.58925104	187.17000000	249.83000000	4.79972398	3318.9900000	345.5602543	8.401
C75RANGE	15	253.33400000	23.07012317	221.08000000	302.44000000	5.95668019	3800.0100000	532.2305829	9.107
SKEW_CPS	15	-0.98866667	0.94123678	-2.23000000	1.46000000	0.24302629	-14.8300000	0.8859267	-95.203
SKEWTONE	15	-2.43400000	0.77666687	-4.21000000	-1.26000000	0.20053452	-36.5100000	0.6032114	-31.909

CLASSIFY=NORMAL DAY=THURSDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	226.35636000	21.05632954	195.80680000	265.06850000	5.43685001	3395.3454000	443.3500703	9.303
TEST_SD	15	35.48114667	6.93628818	23.91480000	45.08040000	1.79094191	532.2172000	48.1120938	19.549
TEST_MED	15	227.21016000	22.01831426	191.74360000	269.62830000	5.68510429	3408.1524000	484.6061627	9.691
TESTMODE	15	226.33333333	26.73592197	188.00000000	294.00000000	6.90318537	3395.0000000	714.8095238	11.813
C5RANGE	15	162.09600000	42.71782612	101.20000000	226.41000000	11.02969528	2431.4400000	1824.8126686	26.353
C95RANGE	15	273.03200000	24.96690472	237.94000000	311.49000000	6.44642708	4095.4800000	623.3463314	9.144
C25RANGE	15	213.32866667	20.05162368	180.36000000	249.65000000	5.17730697	3199.9300000	402.0676124	9.399
C75RANGE	15	243.71333333	23.44412313	211.11000000	293.16000000	6.05324656	3655.7000000	549.6269095	9.620
SKEW_CPS	15	-0.36600000	2.07804441	-1.93000000	5.23000000	0.53654876	-5.4900000	4.3182686	-567.772
SKEWTONE	15	-1.63933333	1.65624130	-3.59000000	2.51000000	0.42763966	-24.5900000	2.7431352	-101.031

CLASSIFY=NORMAL DAY=THURSDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	234.72333333	24.39004483	188.02770000	272.74250000	6.29748250	3520.8503000	594.8742869	10.391
TEST_SD	15	35.32680667	7.36776062	23.54190000	54.37430000	1.90234761	529.9021000	54.2838966	20.856
TEST_MED	15	234.39213333	23.38403569	191.93570000	269.30170000	6.03773205	3515.8820000	546.8131251	9.976
TESTMODE	15	233.33333333	22.54413660	196.00000000	263.00000000	5.82087104	3500.0000000	508.2380952	9.662
C5RANGE	15	178.47733333	40.54510988	97.15000000	221.32000000	10.46870236	2677.1600000	1643.9059352	22.717
C95RANGE	15	287.54666667	34.92219877	237.99000000	369.11000000	9.01687295	4313.2000000	1219.5599667	12.145
C25RANGE	15	220.42400000	21.16173359	180.34000000	249.41000000	5.46393612	3306.3600000	447.8189686	9.600
C75RANGE	15	251.86266667	25.27553715	207.68000000	294.00000000	6.52611563	3777.9400000	638.8527781	10.035
SKEW_CPS	15	-1.07133333	0.79833637	-2.26000000	0.35000000	0.20612955	-16.0700000	0.6373410	-74.518
SKEWTONE	15	-2.23733333	0.70603993	-3.82000000	-1.05000000	0.18229873	-33.5600000	0.4984924	-31.557

TABLE 6. Continued

PLEDGE STIMULI

CLASSIFY=DEVIATE DAY=TUESDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	231.47158000	38.46577193	167.28000000	324.14870000	9.93181961	3472.0737000	1479.6156104	16.618
TEST_SD	15	39.01977333	10.77658701	25.06590000	69.16970000	2.78250280	585.2966000	116.1348275	27.618
TEST_MED	15	232.34183333	40.50565695	160.32860000	321.96960000	10.45851565	3485.1275000	1640.7082449	17.434
TESTMODE	15	232.26666667	44.97057239	161.00000000	344.00000000	11.61135186	3484.0000000	2022.3523810	19.362
C5RANGE	15	152.83666667	52.69944940	95.66000000	262.09000000	13.60693932	2292.5500000	2777.2319667	34.481
C95RANGE	15	289.02266667	46.45446764	221.68000000	383.86000000	11.99449197	4335.3400000	2158.0175638	16.073
C25RANGE	15	219.51533333	38.36377884	152.27000000	302.59000000	9.90548510	3292.7300000	1471.7795267	17.477
C75RANGE	15	247.29600000	44.34427066	165.67000000	356.23000000	11.44964145	3709.4400000	1966.4143400	17.932
SKEW_CPS	15	-0.84333333	1.80785060	-2.87000000	3.31000000	0.46678502	-12.6500000	3.2683238	-214.370
SKEWTONE	15	-1.98266667	1.55274166	-3.95000000	2.06000000	0.40091617	-29.7400000	2.4110067	-78.316

CLASSIFY=DEVIATE DAY=TUESDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	231.19422667	29.87048300	192.89160000	290.13290000	7.71252555	3467.9134000	892.2457546	12.920
TEST_SD	15	37.48442667	10.80733053	21.41750000	55.65740000	2.79044074	562.2664000	116.7983932	28.832
TEST_MED	15	232.21150667	31.34295341	187.70000000	293.82550000	8.09271577	3483.1726000	982.3807286	13.498
TESTMODE	15	230.53333333	31.14451721	192.00000000	294.00000000	8.04147977	3458.0000000	969.9809524	13.510
C5RANGE	15	161.12533333	44.06010941	102.32000000	242.12000000	11.37627133	2416.8800000	1941.2932410	27.345
C95RANGE	15	277.40866667	36.81249009	216.77000000	356.74000000	9.50494407	4161.1300000	1355.1594267	13.270
C25RANGE	15	219.62733333	29.69465788	177.61000000	276.30000000	7.66712770	3294.4100000	881.7727067	13.520
C75RANGE	15	248.00466667	34.59722364	199.78000000	321.28000000	8.93296473	3720.0700000	1196.9678838	13.950
SKEW_CPS	15	-0.22933333	1.56201549	-1.90000000	2.78000000	0.40331066	-3.4400000	2.4398924	-681.111
SKEWTONE	15	-1.92266667	0.80975717	-3.16000000	0.12000000	0.20907840	-28.8400000	0.6557067	-42.116

CLASSIFY=DEVIATE DAY=THURSDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	228.76250000	29.25212344	187.59010000	297.06930000	7.55286579	3431.4375000	855.6867255	12.787
TEST_SD	15	42.97237333	11.52789514	26.13170000	67.80950000	2.97648973	644.5856000	132.8923664	26.826
TEST_MED	15	231.10888000	31.22827446	177.66130000	293.84540000	8.06310580	3466.6332000	975.2051261	13.512
TESTMODE	15	231.20000000	33.20327006	178.00000000	294.00000000	8.57304747	3468.0000000	1102.4571429	14.361
C5RANGE	15	146.67866667	49.58770886	89.92000000	249.13000000	12.80349137	2200.1800000	2458.9406695	33.807
C95RANGE	15	290.09000000	34.33632167	242.02000000	356.94000000	8.86560013	4351.3500000	1178.9829857	11.836
C25RANGE	15	216.67333333	31.04558093	165.59000000	276.60000000	8.01593453	3250.1000000	963.8280952	14.328
C75RANGE	15	246.06000000	33.65967957	187.82000000	321.35000000	8.69089189	3690.9000000	1132.9740286	13.679
SKEW_CPS	15	-0.67866667	1.60297432	-3.05000000	2.66000000	0.41388619	-10.1800000	2.5695267	-236.195
SKEWTONE	15	-2.05333333	1.30609925	-4.45000000	0.94000000	0.33723337	-30.8000000	1.7058952	-63.609

CLASSIFY=DEVIATE DAY=THURSDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	235.27555333	33.76964581	174.83440000	288.50550000	8.71928505	3529.1333000	1140.3886780	14.353
TEST_SD	15	43.47468000	8.62907077	24.36760000	57.95610000	2.22801649	652.1202000	74.4608623	19.848
TEST_MED	15	236.71032667	36.72409376	162.50000000	293.17730000	9.48212024	3550.6549000	1348.6590625	15.514
TESTMODE	15	236.00000000	35.56081310	161.00000000	285.00000000	9.18176246	3540.0000000	1264.5714286	15.068
C5RANGE	15	153.15333333	48.05786953	107.87000000	242.03000000	12.40848856	2297.3000000	2309.5588238	31.379
C95RANGE	15	295.25066667	29.37916304	242.64000000	343.84000000	7.58566728	4428.7600000	863.1352210	9.951
C25RANGE	15	223.48800000	35.14540494	157.01000000	276.28000000	9.07450454	3352.3200000	1235.1994886	15.726
C75RANGE	15	252.57400000	38.81253770	171.59000000	311.57000000	10.02135414	3788.6100000	1506.4130829	15.367
SKEW_CPS	15	-0.22400000	1.59609255	-2.18000000	3.46000000	0.41210932	-3.3600000	2.5475114	-712.541
SKEWTONE	15	-1.73933333	1.51254500	-3.44000000	2.51000000	0.39053744	-26.0900000	2.2877924	-86.961

TABLE 7. Summary of Descriptive Data for Contextual (Picture Stimuli) Fundamental Frequency Data Including Mean, Median, Mode, Standard Deviation, 90% Range, 50% Range, and Skewness in CPS and Semitones for the Normal and Vocally Deviant Children

VOCAL FREQUENCY MEASURES IN NORMAL SPEAKING CHILDREN AND CHILDREN WITH VOCAL DEVIATIONS — 17:58 TUESDAY, SEPTEMBER 20, 1977 — 24

PICTURE STIMULI

CLASSIFY=NORMAL DAY=TUESDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	16	222.74191875	17.42838422	186.73140000	247.83550000	4.35709605	3563.8707000	303.7485764	7.824
TEST_SD	16	36.80308125	6.27347457	25.00950000	46.67690000	1.56836864	588.8493000	39.3564832	17.046
TEST_MED	16	224.69012500	18.13135952	187.18090000	255.01730000	4.53283988	3595.0420000	328.7461979	8.069
TESTMODE	16	225.06250000	21.02528240	178.00000000	256.00000000	5.25632060	3601.0000000	442.0625000	9.342
C5RANGE	16	148.80937500	40.83509332	91.35000000	203.11000000	10.20877333	2380.9500000	1667.5048463	27.441
C95RANGE	16	264.33437500	28.24044121	216.56000000	321.32000000	7.06011030	4229.3500000	797.5225196	10.684
C25RANGE	16	212.21187500	15.94249341	177.43000000	237.47000000	3.98562335	3395.3900000	254.1630963	7.513
C75RANGE	16	239.35750000	21.03787630	203.32000000	276.28000000	5.27196907	3829.7200000	444.6985267	8.810
SKEW_CPS	15	-0.31133333	1.72312783	-2.23000000	2.42000000	0.44490969	-4.6700000	2.9691695	-553.467
SKEWTONE	16	-2.01562500	0.82717164	-3.46000000	-0.25000000	0.20679291	-32.2500000	0.6842129	-41.038

CLASSIFY=NORMAL DAY=TUESDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	231.00115333	24.09201486	188.01030000	265.21490000	6.22053149	3465.0173000	580.4251800	10.429
TEST_SD	15	35.26415333	9.74581661	17.50440000	58.23050000	2.51635903	528.9523000	94.9809414	27.637
TEST_MED	15	233.73023333	22.29420031	195.27780000	269.48080000	5.75633777	3505.9535000	497.0313677	9.538
TESTMODE	15	238.06666667	25.29671539	196.00000000	294.00000000	6.53158383	3571.0000000	639.9238095	10.626
C5RANGE	15	166.06266667	44.69750256	89.83000000	221.44000000	11.54084554	2490.9400000	1997.8667352	26.916
C95RANGE	15	267.94400000	27.31836164	221.83000000	311.81000000	7.05357065	4019.1600000	746.2928829	10.196
C25RANGE	15	220.05866667	20.92606231	184.22000000	255.10000000	5.40306606	3300.8800000	437.9000838	9.509
C75RANGE	15	248.97466667	26.54304264	203.86000000	284.52000000	6.85338414	3734.6200000	704.5331124	10.661
SKEW_CPS	15	-1.13400000	1.37681205	-3.09000000	1.65000000	0.35549134	-17.0100000	1.8956114	-121.412
SKEWTONE	15	-2.47866667	0.94162372	-4.22000000	-0.59000000	0.24312620	-37.1800000	0.8866552	-37.989

CLASSIFY=NORMAL DAY=THURSDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	227.09320667	20.43073944	182.26210000	266.65790000	5.27519424	3406.3981000	417.4151140	8.997
TEST_SD	15	33.66912667	9.27959513	21.05870000	53.77320000	2.39598116	505.0369000	86.1108858	27.561
TEST_MED	15	227.67785333	21.44800124	180.52080000	269.23980000	5.53785011	3415.1678000	460.0167573	9.420
TESTMODE	15	228.33333333	26.34839834	172.00000000	270.00000000	6.80312720	3425.0000000	694.2380952	11.539
C5RANGE	15	161.59400000	43.02590313	113.91000000	226.85000000	11.10924042	2423.9100000	1851.2283400	26.626
C95RANGE	15	265.70866667	23.80881135	211.64000000	311.01000000	6.14740866	3985.6300000	566.8594981	8.960
C25RANGE	15	215.10533333	20.18968862	171.05000000	255.09000000	5.21295519	3226.5800000	407.6235267	9.386
C75RANGE	15	241.54000000	20.87109929	195.58000000	276.97000000	5.38889467	3623.1000000	435.6027857	8.641
SKEW_CPS	15	-0.20733333	2.19616050	-2.78000000	4.90000000	0.56704620	-3.1100000	4.8231210	-1059.241
SKEWTONE	15	-1.77533333	1.61148940	-3.99000000	1.50000000	0.41608477	-26.6300000	2.5968981	-90.771

CLASSIFY=NORMAL DAY=THURSDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	229.22978000	20.65245634	193.35720000	274.85730000	5.33244130	3438.4467000	426.5239528	9.009
TEST_SD	15	32.37333333	6.78244450	20.83520000	47.04290000	1.75121964	485.6000000	46.0015534	20.951
TEST_MED	15	229.82204000	20.47351766	195.66200000	269.63410000	5.28623953	3447.3306000	419.1649255	8.908
TESTMODE	15	229.00000000	19.80620393	192.00000000	263.00000000	5.11393987	3435.0000000	392.2857143	8.649
C5RANGE	15	168.25066667	40.63010926	111.18000000	221.54000000	10.49064910	2523.7600000	1650.8057781	24.149
C95RANGE	15	270.32533333	29.81488336	221.27000000	343.44000000	7.69816978	4054.8800000	888.9272695	11.029
C25RANGE	15	216.99133333	17.99624678	187.33000000	249.84000000	4.64661094	3254.8700000	323.8648981	8.294
C75RANGE	15	244.83466667	22.96881204	207.31000000	293.60000000	5.93052177	3672.5200000	527.5663267	9.381
SKEW_CPS	15	-0.40733333	1.98736533	-2.39000000	4.75000000	0.51313552	-6.1100000	3.9496210	-487.897
SKEWTONE	15	-2.06466667	0.98635597	-3.37000000	-0.24000000	0.25467602	-30.9700000	0.9728981	-47.773

TABLE 7. Continued

VOCAL FREQUENCY MEASURES IN NORMAL SPEAKING CHILDREN AND CHILDREN WITH VOCAL DEVIATIONS — 25 — 17:59 TUESDAY, SEPTEMBER 20, 1977

PICTURE STIMULI

CLASSIFY=DEVIATE DAY=TUESDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	219.66362667	36.49275101	173.16150000	291.36500000	9.42238779	3294.9544000	1331.7208759	16.613
TEST_SD	15	40.74938667	7.55708497	31.26430000	55.17050000	1.95123095	611.2408000	57.1095333	18.545
TEST_MED	15	225.69478000	37.91001585	162.03770000	293.59700000	9.78832400	3385.4217000	1437.1693018	16.797
TESTMODE	15	226.40000000	37.15565714	163.00000000	294.00000000	9.59354942	3396.0000000	1380.5428571	16.412
C5RANGE	15	145.12466667	48.66633111	95.34000000	242.50000000	12.56559266	2176.8700000	2368.4117838	33.534
C95RANGE	15	268.24466667	44.88516297	199.48000000	343.09000000	11.58929925	4023.6700000	2014.6778552	16.733
C25RANGE	15	210.48333333	40.38854039	132.42000000	276.66000000	10.42827629	3157.2500000	1631.2341952	19.188
C75RANGE	15	236.36000000	39.08327428	178.60000000	311.04000000	10.09125803	3545.4000000	1527.5023286	16.535
SKEW_CPS	15	-0.29733333	1.93395770	-1.99000000	4.78000000	0.49934573	-4.4600000	3.7401924	-650.434
SKEWTONE	15	-1.84600000	1.30795806	-3.87000000	1.70000000	0.33771332	-27.6900000	1.7107543	-70.854

CLASSIFY=DEVIATE DAY=TUESDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	227.77776000	30.12667379	182.63030000	280.25800000	7.77867372	3416.6664000	907.61647	13.226
TEST_SD	15	36.76448667	9.40337409	22.36880000	51.82580000	2.42794075	551.4673000	88.42344	25.577
TEST_MED	15	231.21102667	31.30859107	180.21810000	284.31020000	8.08384345	3468.1654000	980.22787	13.541
TESTMODE	15	385.13333333	586.53240888	181.00000000	2502.00000000	151.44201677	5777.0000000	344020.26667	152.293
C5RANGE	15	167.06800000	45.28928889	97.98000000	242.54000000	11.69364411	2506.0200000	2051.11969	27.108
C95RANGE	15	436.08533333	646.34258875	211.57000000	2768.72000000	166.88493881	6541.2800000	417758.74203	148.215
C25RANGE	15	226.32400000	50.42805962	168.58000000	373.40000000	13.02046901	3394.8600000	2542.98920	22.281
C75RANGE	15	243.86933333	33.15039893	187.86000000	293.75000000	8.55939620	3658.0400000	1098.94895	13.594
SKEW_CPS	14	-0.24714286	2.29088639	-3.57000000	4.65000000	0.61226514	-3.4600000	5.24816	-926.948
SKEWTONE	15	-2.01333333	1.45785883	-4.48000000	0.83000000	0.37641753	-30.2000000	2.12535	-72.410

CLASSIFY=DEVIATE DAY=THURSDAY TIME=MORNING

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	225.97544667	26.87569917	187.77530000	279.49760000	6.93927569	3389.6317000	722.3032061	11.893
TEST_SD	15	41.61646667	9.15127350	28.27730000	61.30110000	2.36284866	624.2470000	83.7458067	21.990
TEST_MED	15	230.67317333	32.13640738	174.53450000	284.13540000	8.29756483	3460.0976000	1032.7487111	13.932
TESTMODE	15	231.86666667	33.18964268	172.00000000	285.00000000	8.56952889	3478.0000000	1101.5523810	14.314
C5RANGE	15	143.56333333	45.76223859	100.87000000	249.57000000	11.81575920	2153.4500000	2094.1824810	31.876
C95RANGE	15	276.60466667	34.64482045	221.00000000	356.07000000	8.94525417	4149.0700000	1200.2635838	12.525
C25RANGE	15	216.73933333	30.07761780	162.54000000	269.74000000	7.76600752	3251.0900000	904.6630924	13.877
C75RANGE	15	242.35000000	31.69708707	187.09000000	293.40000000	8.18415269	3635.2500000	1004.7053286	13.079
SKEW_CPS	15	-0.63266667	1.78354970	-2.92000000	2.95000000	0.46051055	-9.4900000	3.1810495	-281.910
SKEWTONE	15	-1.82933333	1.43219844	-4.33000000	1.87000000	0.36979205	-27.4400000	2.0511924	-78.291

CLASSIFY=DEVIATE DAY=THURSDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	226.77260667	29.35654372	171.25890000	271.97430000	7.57982700	3401.5891000	861.8066594	12.945
TEST_SD	15	40.56421333	10.98925110	19.81420000	60.70633000	2.83741243	608.4632000	120.7636397	27.091
TEST_MED	15	230.74658667	32.20982938	157.98210000	276.84110000	8.31654219	3461.1988000	1037.4731089	13.959
TESTMODE	15	232.60000000	34.26743560	161.00000000	285.00000000	8.84781383	3489.0000000	1174.2571429	14.732
C5RANGE	15	151.31133333	42.32510955	106.28000000	249.23000000	10.92829629	2269.6700000	1791.4148981	27.972
C95RANGE	15	278.65533333	31.75453350	226.53000000	321.10000000	8.19398530	4179.8300000	1008.3503981	11.396
C25RANGE	15	217.64333333	31.15538217	150.55000000	269.44000000	8.04426509	3264.6500000	970.6578381	14.315
C75RANGE	15	244.10666667	34.28683476	165.87000000	284.83000000	8.85282267	3661.6000000	1175.5870381	14.046
SKEW_CPS	15	-0.64533333	1.90802017	-3.13000000	2.92000000	0.49264869	-9.6800000	3.6405410	-295.664
SKEWTONE	15	-1.91000000	1.61620808	-5.24000000	2.51000000	0.41730313	-28.6500000	2.6121286	-84.618

TABLE 8. Summary of Descriptive Data for Free Field Fundamental Frequency Values Including Mean, Median, Mode, Standard Deviation, 90% Range, 50% Range, and Skewness in CPS and Semitones for the Normal and Vocally Deviant Children

VOCAL FREQUENCY MEASURES IN NORMAL SPEAKING CHILDREN AND CHILDREN WITH VOCAL DEVIATIONS — 17:58 TUESDAY, SEPTEMBER 20, 1977 — 28

FREE FIELD STIMULI

CLASSIFY=NORMAL DAY=TUESDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	223.34692000	19.03580554	196.58250000	259.11870000	4.91502386	3350.2038000	362.3618926	8.523
TEST_SD	15	43.97816000	8.90837760	27.26700000	58.10200000	2.30013321	659.[illegible]24000	79.3591915	20.256
TEST_MED	15	228.90683333	16.91949705	199.80170000	255.43370000	4.36859535	3433.6025000	286.2693805	7.391
TESTMODE	15	232.86666667	16.12835421	208.00000000	256.00000000	4.16432315	3493.0000000	260.1238095	6.926
C5RANGE	15	126.91133333	32.19571308	103.73000000	231.46000000	8.31289737	1903.6700000	1036.5639410	25.369
C95RANGE	15	284.99866667	40.32468703	237.12000000	369.28000000	10.41178942	4274.9800000	1626.0803838	14.149
C25RANGE	15	214.87866667	17.24762752	187.46000000	249.01000000	4.45331828	3223.1800000	297.4806552	8.027
C75RANGE	15	245.39933333	19.55696970	211.95000000	269.73000000	5.04958786	3680.9900000	382.4750638	7.969
SKEW_CPS	15	-0.84933333	1.07895099	-2.51000000	2.02000000	0.27858395	-12.7400000	1.1641352	-127.035
SKEWTONE	15	-1.73666667	0.59495098	-3.13000000	-0.52000000	0.15361568	-26.0500000	0.3539667	-34.258

CLASSIFY=DEVIATE DAY=TUESDAY TIME=AFTERNOON

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	STD ERROR OF MEAN	SUM	VARIANCE	C.V.
TESTMEAN	15	231.55760000	28.12503493	178.31640000	266.01650000	7.26185279	3473.3640000	791.0175899	12.146
TEST_SD	15	54.66640667	13.64012232	36.07450000	77.07930000	3.52186444	819.9961000	186.0529370	24.952
TEST_MED	15	237.33906000	28.81775757	184.84720000	284.05170000	7.44071301	3560.0859000	830.4631512	12.142
TESTMODE	15	253.60000000	41.45186537	181.00000000	322.00000000	10.70282562	3804.0000000	1718.2571429	16.345
C5RANGE	15	122.00600000	38.57530498	89.92000000	216.10000000	9.96010092	1830.0900000	1488.0541543	31.618
C95RANGE	15	308.09466667	54.75288980	211.23000000	399.34000000	14.13713536	4621.4200000	2997.8789410	17.771
C25RANGE	15	213.66200000	22.22916173	168.80000000	242.68000000	5.73954488	3204.9300000	494.1356314	10.404
C75RANGE	15	262.31866667	36.48133101	199.50000000	321.23000000	9.41943916	3934.7800000	1330.8875124	13.907
SKEW_CPS	15	-0.57000000	0.77760622	-1.59000000	1.36000000	0.20077706	-8.5500000	0.6046714	-136.422
SKEWTONE	15	-1.48133333	0.42746540	-2.41000000	-0.57000000	0.11037109	-22.2200000	0.1827267	-28.857

TABLE 9. Correlation Matrix of Severity, 15 Perceived Voice Characteristics and Mean Fundamental Frequency

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 210

SEVERITY

SEVERITY	HRSHVOIC	BRTYCONT	PITCHLEV	STRNSTRG	MONOPTCH	MONOLOUD	LOUDOVER	PITCHBRK	FUNDFREQ
1.00000	0.59166	0.58322	0.54847	0.48549	0.48018	0.42325	0.37986	0.22048	-0.20795
0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0013	0.0025

PITCHLEV

PITCHLEV	SEVERITY	MONOPTCH	MONOLOUD	HRSHVOIC	LOUDOVER	BRTYCONT	VOICTREM	STRNSTRG	HRSEVOIC
1.00000	0.54847	0.54156	0.45564	0.40821	0.30551	0.28411	0.24023	0.18788	0.18453
C.CCCO	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	0.0063	0.0073

PITCHBRK

PITCHBRK	VOICTREM	STRNSTRG	HRSEVOIC	MONOLOUD	SEVERITY	LOUDOVER	HRSHVOIC	MONOPTCH	ALTRLOUD
1.00000	0.38537	0.33076	0.30738	0.25113	0.22048	0.20511	0.14890	0.14344	0.13095
0.0000	0.0001	0.0001	0.0001	0.0002	0.0013	0.0028	0.0310	0.0378	0.0582

MONCPTCH

MONOPTCH	MONOLOUD	PITCHLEV	SEVERITY	HRSEVOIC	LOUDOVER	FUNDFREQ	BRTYCONT	LOUDVARI	HRSHVOIC
1.00000	0.69043	0.54156	0.48018	0.27630	0.26781	-0.25588	0.24379	0.20632	0.16956
C.CCOO	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0004	0.0027	0.0139

VOICTREM

VOICTREM	PITCHBRK	PITCHLEV	STRNSTRG	ALTRLOUD	MONOPTCH	SEVERITY	LOUDOVER	MONOLOUD	HRSHVOIC
1.00000	0.38537	0.24023	0.14012	0.13211	0.11394	0.09192	0.09007	0.07715	0.06625
C.0000	0.0001	0.0004	0.0425	0.0560	0.0996	0.1846	0.1936	0.2657	0.3394

MONCLOUD

MONOLOUD	MONOPTCH	PITCHLEV	SEVERITY	LOUDOVER	HRSEVOIC	FUNDFREQ	BRTYCONT	PITCHBRK	LOUDVARI
1.00000	0.69043	0.45564	0.42325	0.36767	0.34004	-0.27895	0.26779	0.25113	0.24698
C.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0003

LOUDVARI

LOUDVARI	BRTYTRAN	MONOLOUD	LOUDOVER	MONOPTCH	PITCHLEV	LOUDECAY	ALTRLOUD	BRTYCONT	SEVERITY
1.00000	0.33805	0.24698	0.22345	0.20632	0.15143	0.14151	0.13454	0.13088	0.09737
0.0000	0.0001	0.0003	0.0011	0.0027	0.0282	0.0405	0.0516	0.0583	0.1598

LOUDECAY

LOUDECAY	ALTRLOUD	LOUDVARI	LOUDOVER	SEVERITY	MONOLOUD	PITCHLEV	FUNDFREQ	VOICSTOP	PITCHBRK
1.00000	0.19280	0.14151	0.13955	0.07770	0.07261	0.06500	-0.05539	-0.04944	-0.04916
0.0000	0.0051	0.0405	0.0434	0.2623	0.2950	0.3486	0.4245	0.4761	0.4786

TABLE 9. Continued

VOCAL FREQUENCY MEASURES IN NORMAL SPEAKING CHILDREN
AND CHILDREN WITH VOCAL DEVIATIONS

20:48 TUESDAY, SEPTEMBER 20, 1977

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 210

ALTRLOUD

ALTRLOUD	LOUDOVER	LOUDECAY	STRNSTRG	PITCHLEV	HRSEVOIC	LOUDVARI	VOICTREM	PITCHBRK	FUNDFREQ
1.00000	0.27033	0.19280	0.17556	0.16263	0.15934	0.13454	0.13211	0.13095	0.12676
0.0000	0.0001	0.0051	0.0108	0.0184	0.0209	0.0516	0.0560	0.0582	0.0668

LOUDOVER

LOUDOVER	SEVERITY	MONOLOUD	PITCHLEV	HRSHVOIC	ALTRLOUD	MONOPTCH	STRNSTRG	LOUDVARI	BRTYTRAN
1.00000	0.37986	0.36767	0.30551	0.29484	0.27033	0.26781	0.24249	0.22345	0.21406
C.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0004	0.0011	0.0018

HRSHVOIC

HRSHVOIC	SEVERITY	STRNSTRG	PITCHLEV	LOUDOVER	MONOLOUD	MONOPTCH	PITCHBRK	BRTYCONT	ALTRLOUD
1.00000	0.59166	0.51663	0.40821	0.29484	0.20811	0.16956	0.14890	0.14279	0.11678
C.0000	0.0001	0.0001	0.0001	0.0001	0.0024	0.0139	0.0310	0.0387	0.0914

HRSEVOIC

HRSEVOIC	MONOLOUD	PITCHBRK	MONOPTCH	SEVERITY	PITCHLEV	ALTRLOUD	LOUDOVER	STRNSTRG	FUNDFREQ
1.00000	0.34004	0.30738	0.27630	0.20050	0.18453	0.15934	0.14983	0.11941	-0.10337
C.0000	0.0001	0.0001	0.0001	0.0035	0.0073	0.0209	0.0300	0.0843	0.1354

BRTYCONT

BRTYCONT	SEVERITY	PITCHLEV	MONOLOUD	MONOPTCH	LOUDOVER	STRNSTRG	FUNDFREQ	HRSHVOIC	BRTYTRAN
1.00000	0.58322	0.28411	0.26779	0.24379	0.20623	0.17804	-0.16076	0.14279	0.14170
0.0000	0.0001	0.0001	0.0001	0.0004	0.0027	0.0097	0.0198	0.0387	0.0402

BRTYTRAN

BRTYTRAN	LOUDVARI	LOUDOVER	SEVERITY	MONOLOUD	MONOPTCH	BRTYCONT	VOICSTOP	VOICTREM	FUNDFREQ
1.00000	0.33805	0.21406	0.20531	0.19165	0.15546	0.14170	0.05478	-0.04752	-0.04468
C.0000	0.0001	0.0018	0.0028	0.0053	0.0242	0.0402	0.4297	0.4934	0.5196

STRNSTRG

STRNSTRG	HRSHVOIC	SEVERITY	PITCHBRK	LOUDOVER	PITCHLEV	BRTYCONT	ALTRLOUD	FUNDFREQ	VOICTREM
1.00000	0.51663	0.48549	0.33076	0.24249	0.18788	0.17804	0.17556	0.17540	0.14012
0.0000	0.0001	0.0001	0.0001	0.0004	0.0063	0.0097	0.0108	0.0109	0.0425

VOICSTOP

VOICSTOP	SEVERITY	LOUDOVER	ALTRLOUD	BRTYCONT	MONOLOUD	MONOPTCH	FUNDFREQ	BRTYTRAN	LOUDVARI
1.00000	0.16670	-0.13367	-0.07470	0.06987	-0.06916	0.05622	-0.05598	0.05478	-0.05076
C.0000	0.0156	0.0531	0.2812	0.3136	0.3185	0.4176	0.4197	0.4297	0.4644

TABLE 9. Continued

VOCAL FREQUENCY MEASURES IN NORMAL SPEAKING CHILDREN
AND CHILDREN WITH VOCAL DEVIATIONS

20:48 TUESDAY, SEPTEMBER 20, 1977

CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 210

FUNDFREQ

	FUNDFREQ	MONOLOUD	MONOPTCH	SEVERITY	STRNSTRG	BRTYCONT	PITCHLEV	ALTRLOUD	HRSEVOIC	HRSHVOIC
FUNDFREQ	1.00000	-0.27895	-0.25588	-0.20795	0.17540	-0.16076	-0.14954	0.12676	-0.10337	-0.09484
	0.0000	0.0001	0.0002	0.0025	0.0109	0.0198	0.0303	0.0668	0.1354	0.1709

TABLE 10. Summary of Regression Coefficients for Major Perceptual Variables in Prediction of Severity Rating of Vocal Production

STEPWISE REGRESSION PROCEDURE FOR DEPENDENT VARIABLE SEVERITY

STEP 12 VARIABLE FUNDFREQ REMOVED R SQUARE = 0.77611168

	DF	SUM OF SQUARES	MEAN SQUARE	F	PROB>F
REGRESSION	10	236.64960723	23.66496072	68.98	0.0001
ERROR	199	68.26734515	0.34305199		
TOTAL	209	304.91695238			

	B VALUE	STD ERROR	TYPE II SS	F	PROB>F
INTERCEPT	-0.83553975				
PITCHLEV	0.19397752	0.05026722	5.10849568	14.89	0.0002
MONOPTCH	0.19011918	0.05702692	3.81286974	11.11	0.0010
LOUDECAY	0.31955976	0.12683042	2.17779649	6.35	0.0125
ALTRLOUD	-0.32162936	0.13840667	1.85249604	5.40	0.0211
HRSHVOIC	0.40962163	0.05269944	20.72591122	60.42	0.0001
HRSEVOIC	0.19841365	0.05407553	4.61850573	13.46	0.0003
BRTYCONT	0.43993452	0.04058374	40.31177547	117.51	0.0001
BRTYTRAN	0.20829375	0.05770271	4.47012788	13.03	0.0004
STRNSTRG	0.25882317	0.04986773	9.24117331	26.94	0.0001
VOICSTOP	0.48750749	0.11530099	6.13276632	17.88	0.0001

NO OTHER VARIABLES MET THE 0.5000 SIGNIFICANCE LEVEL FOR ENTRY INTO THE MODEL.